DOCUMENT RESUME

ED 237 110 IR 050 532

TITLE	Telecommunications in ARL Libraries. SPEC Kit 98.
INSTITUTION	Association of Research Libraries, Washington, D.C. Office of Management Studies.
PUB DATE	Oct 83
NOTE	138p.
AVAILABLE FROM	Systems and Procedures Exchange Center. Association of Research Libraries, Office of Management Studies, 1527 New Hampshire Ave., N.W., Washington, DC (single copies $15.00; ARL member price, $7.50).
PUB TYPE	Collected Works - General (020) -- Reports - Descriptive (141)
EDRS PRICE	MF01 Plus Postage. PC Not Available from EDRS.
DESCRIPTORS	*Academic Libraries; *Computer Oriented Programs; Higher Education; Information Science; *Library Cooperation; *Library Networks; Library Services; Models; Program Descriptions; *Public Libraries; Research Libraries; Standards; *Telecommunications
IDENTIFIERS	Association of Research Libraries; Distributed Data Processing Systems

ABSTRACT

This 11-document kit introduces the current and planned uses of telecommunications facilities in the computerized information systems of several research libraries, public libraries, and library groups contacted in 1983. The first two documents are excerpts from reports on networks: "Telecommunications: An Overview for OCLC," and "Request for Information, Carnegie Study on Distributed Processing." Seven documents relating to interconnection among libraries are presented: (1) a Columbia University Memorandum; (2) a draft of "Scholarly Communications in the 1990's and Beyond: A Strategic Assessment of the Library and Computing Functions of Columbia University"; (3) excerpts from "University of California at San Diego Telecommunications System Project: Request for Information. Final Report and Recommendation"; (4) excerpts from "Administrative Information Systems Plans," (Yale University); (5) "Network Library System (NLS) Project," (University of Wisconsin-Madison, University of Chicago); (6) "Automated Library Circulation System Communication System Configuration," (Peninsula Libraries Automated Network, California); and (7) excerpts from "Telecommunications Research Paper," by Patricia Copenhaven Rich. Excerpts of "Automation Requirements--The Branch Libraries" from the New York Public Library discuss gateways and links, and excerpts from two papers, "Application Level Protocol Development for Library and Information Science Applications: volume 1, Service Definition," and "Telecommunications Information Center," (The George Washington University), examine standards. Five selected references are listed. (LMM)

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Kit 98

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Systems and Procedures Exchange Center

ISSN 1060 3574

TELECOMMUNICATIONS IN ARL LIBRARIES

The implications of telecommunications technology for large research and academic libraries extend to many areas of library operations, and also to campus, regional, network, national, and international efforts. Library administrators are familiarizing themselves with the options and capabilities of telecommunications as it relates to their libraries' needs and roles, and are actively sharing in planning and implementing telecommunications systems. This flyer/kit provides an introduction to the current and planned uses of telecommunications facilities in the computerized information systems of several members of the Association of Research Libraries, plus a few public libraries and library groups, contacted in Summer 1983.

Telecommunications facilities used by research libraries include dial-up and leased circuits provided by local telephone companies, on-campus facilities which may be privately owned, and services from carriers such as Telenet and Tymnet. The role of these facilities in library automation systems is changing due to developments in both telecommunications and computers.

In the 1970's research libraries became users of large, centralized information networks such as OCLC, RLIN, and WLN. Data processing in these systems was performed by large scale computers at the network headquarters. Telephone circuits leased from the Bell System connected video display terminals to the central computer, and the use of these telecommunications facilities usually was managed by the information network. As the result of significant decreases in the cost of computer equipment, the trend now is toward decentralization and distribution of computerized information processing systems. This decentralization puts individual institutions in control of data processing and storage, and has led to the use of telcommunications to interconnect these distributed systems, thereby enhancing information-sharing.

LOCAL SYSTEMS. Many libraries are planning -- or already have -- automated local information processing systems. Some are for a single purpose, e.g., automated circulation or on-line catalogs. Others are integrated systems that support a variety of library processes and may communicate with other systems. The major information networks are developing local systems to supplement their centralized services.

In addition to such local systems, another level of distribution is taking place based on micro, or personal, computer technology. OCLC and WLN have announced the use of the IBM Personal Computer as the basis for their next generation of terminals. In the past, the library staff had terminals; now they will have terminals that also are desk-top computers. Further, the microcomputer personal workstation provides distribution of information processing to individual researchers. A number of projects are developing software to enable scholars and professors to access the online catalogs of libraries and search bibliographic data bases from their desktop workstations.

INTERCONNECTION. The distribution of computerized information processing and storage carries with it the requirement for interconnecting separate systems. Distribution without interconnection could produce a new isolation that might undermine much of the resource sharing that information networks were built to provide.

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Within individual campuses, the telecommunications facilities for interconnecting systems generally will be provided by either local area networks (LANS) which also may provide broadcast video communications, or by private branch exchange (PBX), a computerized telephone circuit switch that can provide both voice and data communication service. Many research libraries already have access to such facilities at their institutions. Others, such as Yale, include them in their planning. Given the importance of telecommunications to their information processing needs, research libraries need to take an active role in both defining the requirements for local facilities and in evaluating alternative systems, e.g., the University of California at San Diego.

At Columbia University, the library has an active role in telecommunications planning, taking the view that in an information economy, value is the result of both the amount of information available and also the rate at which that information circulates. Research libraries have a wealth of information, and their effective use of telecommunications can produce a great deal of value by facilitating the circulation of that information.

While LAN or PBX technologies can serve a single campus, they can operate only within a limited geographical range. Beyond that range, other interconnections must be made. Some local public and county systems have interconnected mini- or microcomputers. The multi-campus University of Maryland foresees increased use of satellite telecommunications facilities for this decade. In the 1990's, the maturing optical fiber technology -- the transmission of light signals through flexible glass wires -- is expected to provide economical alternatives to satellite and land-based facilities.

GATEWAYS AND LINKS. Interconnection of systems composed of the same hardware and software is fairly simple; it is much more complex to interconnect heterogeneous systems. In their planning, the Branch Libraries of the New York Public Libraries have defined the need for gateways to other systems. A major U.S. effort to connect dissimilar systems is the WLN/RLG/LC Linked Systems Project, funded by the Council on Library Resources. This effort will provide telecommunications among programs running in different hardware and software configurations. The protocol (rules and formats) for exchanging messages among systems is designed to be independent of any specific hardware, software, or vendor. The Bibnett project in Norway and the Bibliographic Interest Group of Canada's iNET also are working to link systems.

STANDARDS. The development and use of telecommunications standards is essential for the success of these interconnecting links. The International Organization for Standardization (ISO), with strong U.S. participating through the American National Standards Institute (ANSI), is developing protocol standards to allow the interconnection of dissimilar systems. A fundamental part of this work, the Basic Reference Model for Open Systems Interconnection (OSI), has been adopted by the Linked Systems Project. Working with the the National Bureau of Standards, several U.S. companies will participate in a major demonstration of the first of these OSI protocols at the 1984 National Computer Conference. Vendor-supported hardware should be available by late 1984. The communications procedures being developed for OSI are designed for general applications. Only a relatively small set of specific procedures will need to be added to tailor this environment to a particular task. Within the library and information science community, subcommittee D of the Z39 American National Standards Committee is developing an information retrieval application protocol.

TRENDS. Thus far, research libraries have been slow to embrace some other telecommunications technologies, such as facsimile transmission, videotex, and teletext. In order to generate adequate resolution, facsimile transmission requires an extremely high volume of data transmission and therefore requires higher speed telecommunications facilities to be economical. Costs, of both data transmission and of library staff, and incompatability among telefacsimile machines have slowed the adoption of this technology. In addition, videotex and teletext have found few if any applications in public or research libraries up to this time.

The break-up of AT&T's Bell System, to be completed by January of 1984, will have a substantial impact on all telecommunications users. Local rates are likely to rise while long distance rates may fall. Research libraries and their parent institutions will have to commit more resources to the management of telecommunications in this competitive, multi-vendor environment.

SPEC Kit #98 (October 1983, 129 pages) on Telecommunications in ARL Libraries contains two documents on networks, seven on interconnection among libraries, one on gateways/links, and two on standards, plus a short list of references. SPEC Kits are available mainly by subscription. Single copies may be purchased, when available, for $15.00, with checks made payable to "ARL Office of Management Studies." Outside the U.S. and Canada, add $5.00 per order for postage and handling. Ordering address is: SPEC Center, ARL/OMS, 1527 New Hampshire Ave., N.W., Washington, D.C. 20036. (ARL members receive kits for $7.50.)

This kit/flyer was prepared as part of the OMS Collaborative Research-Writing Program by Wayne Davision, Manager, Communications Development, The Research Libraries Group, Inc.

USES OF SPEC KITS

The Systems and Procedures Exchange Center (SPEC) is a clearinghouse operated by the Association of Research Libraries, Office of Management Studies that provides a central source of timely information and materials on the management and operations of large academic and research libraries. It facilitates the exchange of knowledge and documents through SPEC Kits, which are distributed ten times each year to ARL members and other interested libraries. The Kits include topically-arranged groupings of unedited primary source documents – selected for their value to administrators and decision-makers – that illustrate a wide range of alternative approaches to specfic issues.

Kit documents come from general membership surveys and from selected libraries contacted directly by SPEC, and most Kits are produced within six months of surveys. The documents' value comes from their variety of ideas, methods, and solutions. They are not viewed as finished products, but rather as points of departure for a library's planning efforts and as stimulants to innovative approaches to problem-solving. As such, Kits do not present answers or prescriptions for any one library; instead they illustrate how selected ARL members are planning for or dealing with particular issues. The worth of any one Kit to a particular library will depend upon the specific topic covered and the library's stage of development in that area.

Materials are selected according to the following criteria:

- Presents an approach of potential value to administrators and decision-makers
- Timely, and dealing directly with the topic under consideration
- Probability of application of ideas or thinking to other library situations
- Illustrative of actual practice, rather than theoretical
- Understandable, readable communication

All together, the materials should provide a range of alternative approaches that complement each other, provide variety, and stimulate comparison and contrast.

Libraries can take advantage of the Kit compilations in a number of ways. Administrators can evaluate the assumptions, methods, and results of other libraries' approaches; compare and contrast them; and use the learnings in their own situations. Library staff members can use the kits as professional development and current awareness tools. Committees and task forces can use them to begin a review of current practices. And the Kits can identify other persons or places to contact for further information. Back-up files in the SPEC office also are available for loan to member libraries. In addition, SPEC will conduct on-demand surveys or analyses geared specifically for a single library.

EVALUATION

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2. Please indicate how useful the Kit was for these purposes.

☐ Very Useful ☐ Quite Useful ☐ Somewhat Useful ☐ Not Useful

3. Do you have suggestions for this Kit or for future Kits?

(optional)

NAME _____

LIBRARY _____

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EXCERPTS

TELECOMMUNICATIONS:

An Overview for OCLC

by

Larry L. Learn
OCLC Online Computer Library Center

1983 April 7

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Communications Links in the OCLC Online System

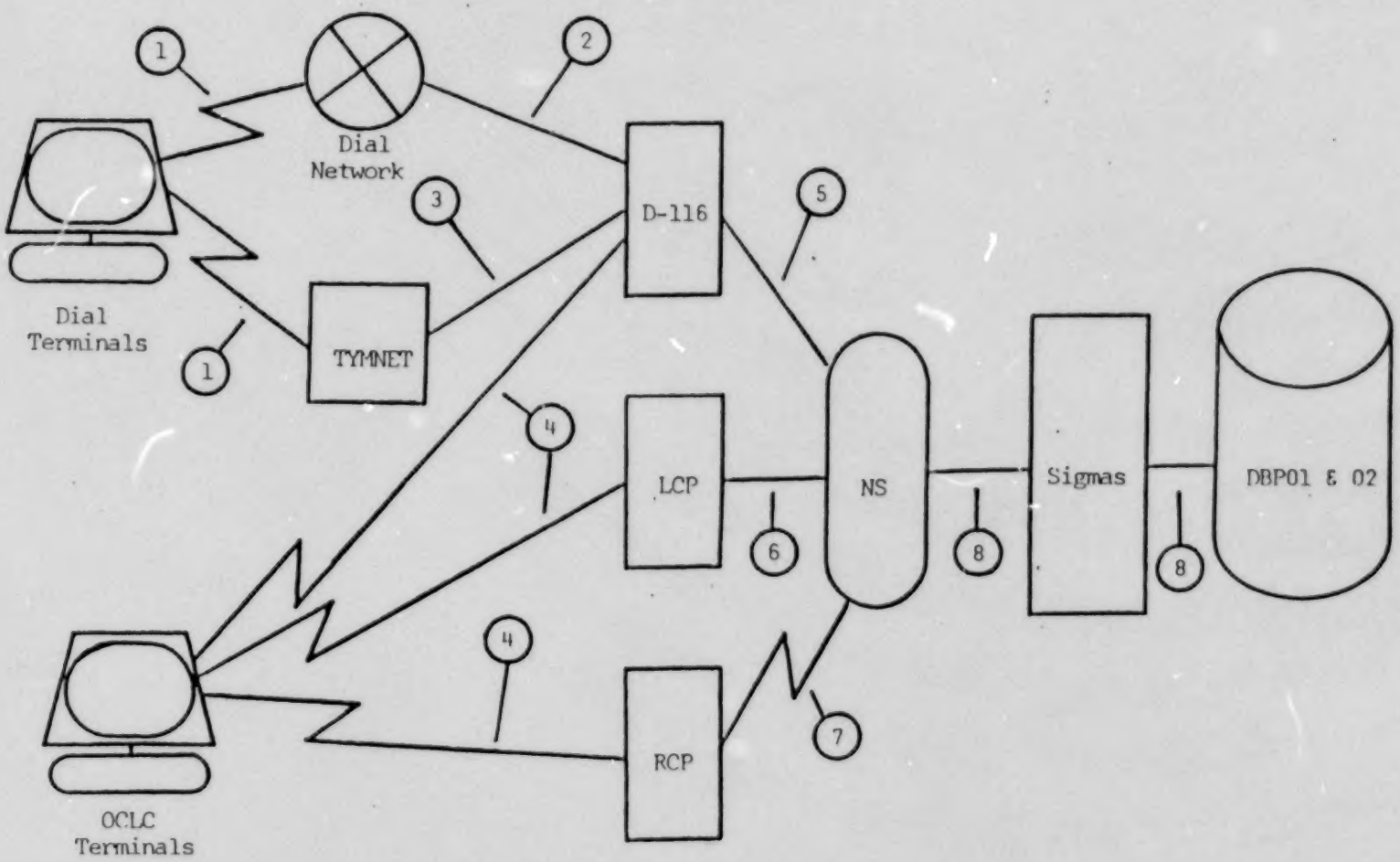


FIGURE 1

handled in an identical fashion by the CP.

4. OCLC Terminal Network. At the present time OCLC has installed on the OCLC telecommunications network nearly 5000 user terminals of the OCLC Model 100, 105, or 110 variety. The OCLC terminal network differs in many substantive ways from the dial facility previously described, both in terms of the physical facility and equipment as well as the logical configuration and protocol used on the network.

The communications facilities are dedicated, leased facilities, so OCLC has exclusive use of the facilities on a long-term basis. The circuits are 4-wire circuits configured in such a way that one 2-wire loop carries information from the OCLC computers to the terminals and the other 2-wire loop carries information from the terminals to the OCLC computer. The circuits are independent and configured in FDX mode in the sense that one loop is simplex outbound and one loop is simplex inbound. Each loop has a bandwidth of at least 3150 Hz. These circuits have the latent capability to carry at least 6300 bps in each direction since OCLC uses quadrature phase-shift keying (PSK-4 phase) which encodes 2 bits in each "symbol." OCLC operates over these facilities at 2400 bps, although an additional 110 bps is used for diagnostic and telemetry purposes (i.e., maintenance use) independent of the user data. Aggregate bit rates in excess of 9600 bps are routinely achieved over this class of facilities (i.e., Bell 3002, unconditioned, 4-wire, private line), although the cost of the more sophisticated equipment required may become a factor.

The facilities are utilized in synchronous mode via 2400 bps FDX modem equipment conforming to the CCITT-V.26 standard. As previously indicated, 4-phase PSK modulation is used to impose the di-bit signal elements (symbols) on the analog telecommunications facilities. The terminal to modem and computer to modem interface conforms to the EIA-RS-232-C standard.

These circuits are "party-line" or so-called "multi-drop" lines wherein the CP and several terminals (typically 20 to 30) are connected to the same line. The transmit section of the modem can be turned on and off by the terminal or computer using an electronic signal in much the same manner as the microphone button on a two-way radio. Activating this signal, called request to send (RTS), causes the modem transmitter to send onto the line the "carrier" signal upon which the actual data can then be imposed (or modulated). Only one modem at a time can cause a carrier to be placed on a 2-wire loop. Should two or more modems attempt to impose a carrier signal on the same 2-wire loop at the same time, the resulting interference would render both signals unintelligible. This type of configuration is called a switched carrier circuit, and control of when a modem can and cannot impose carrier on the circuit is specified by the protocol.

As indicated, the OCLC circuits are 4-wire (i.e., two independent loops). The outbound (i.e., from the computer) loop is configured in such a way as to connect the transmit section of the computer modem (called the master modem) to the receive section of all the terminal

modems. No terminal modem transmit section is connected to the outbound loop. The computer always asserts RTS and transmits continuously to the various terminals via the outbound circuit (in fact, the master modem is often configured in such a way as to send carrier continuously - even if RTS is not asserted by the computer). The outbound loop is said to have "continuous carrier."

All terminal (slave) modem transmit sections are connected to the other (inbound) 2-wire loop which is connected to the receive section of the computer (master) modem. The various terminals, according to the protocol discussed below and upon command of the CP, turn on their respective transmitters and send data to the CP over the same 2-wire loop (inbound), one at a time. Since the various transmitters are not all "tuned" perfectly the same, the computer modem's receive section must adjust (said to "train") on the various signals before data can be communicated. This requires about 7 ms (milliseconds or thousandths of a second) with the OCLC modem equipment operating at 2400 bps.

The OCLC terminal network utilizes a special protocol unique to OCLC. Special computer programs to implement this protocol reside both in the communications computers (i.e., D-116 CP, local communications processor, and remote communications processor) and in each of the terminal devices in the field. At the present time this program is implemented in the OCLC terminal equipment in such a way as not to be easily changed (i.e., implemented in micro-code and stored in read only memory). Therefore, it would not be a simple matter to change protocols as far as the terminal is concerned.

The OCLC protocol is a character- (byte) oriented protocol. This requires that the bit-sequential data be organized into 8-bit bytes before it can be understood. The process is called byte synchronization and is accomplished by starting each message with two or more (typically 4) synch characters. The characters conform to the ASCII (i.e., American Standard Code for Information Interchange) standard which is a 7-bit code and uses an odd parity bit to complete the 8-bit byte. The odd parity bit (i.e., the parity bit is chosen such that the binary sum of the bits within each byte is always one or odd excluding any carry) is often called a vertical redundancy check or VRC. In addition, the bits within each character of the message are summed in a like manner by position of significance within the character (see Figure 3) throughout each message to create a terminating character called a longitudinal redundancy check (LRC), which is chosen so that the various sums are always odd, excluding synch characters. The combination of these two entities (i.e., VRC and LRC) enable the detection of certain (but not all) errors which might occur during a transmission.

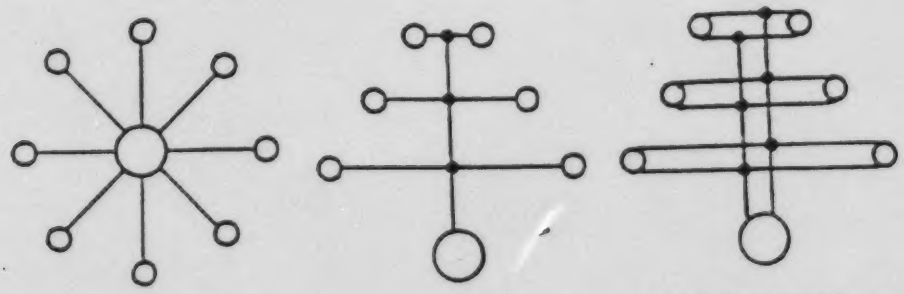
It is the responsibility of the CP (i.e., D116, LCP, or RCP) within the OCLC terminal network to control the flow of communications over the network, making sure that two or more terminals do not transmit simultaneously, that every terminal gets the opportunity to use the network in an equitable manner, and that the integrity of the data is insured. The CP does this by addressing each terminal on the

Character and Message Parity Structure

Character #	1	2	3	4	5	6	7	8	9	10
Parity Bit	0	0	0	1	1	0	0	1	1	1
ASCII Character Bit 7	0	0	0	1	1	0	1	1	0	1
Bit 6	0	0	0	0	0	0	0	0	0	1
Bit 5	1	1	0	0	0	0	0	0	0	1
Bit 4	0	0	0	0	0	0	0	0	0	1
Bit 3	1	1	0	0	0	0	0	1	0	0
Bit 2	1	1	0	0	1	1	1	0	1	1
Bit 1	0	0	1	1	0	0	1	0	1	1
.	SYNCH	SYNCH	SOH	A	B	STX	C	D	ETX	LRC

FIGURE 3

STAR, TREE, and DOUBLE TREE Configurations



"STAR" "TREE" "DOUBLE TREE"

FIGURE 4

circuit using an algorithm designed to provide the most equitable utilization of the network (remember that all terminals listen to the CP at all times via the outbound link). When a terminal recognizes its specific address (its name, if you will), it asserts RTS to turn on its transmitter, and upon receiving permission from its modem via a signal called clear to send (CTS), responds to the request of the CP. This is called a poll-response protocol. After the transmission has been completed, the terminal turns off its transmitter (i.e., drops RTS) so that other terminals can then use the same circuit.

The CP will usually address a terminal for one of two reasons; namely, to send data or control information, or to solicit information from the terminal. The terminal will usually accept the information from the CP, perform the requested operation, or acknowledge the opportunity to send data to the CP. In the latter case, the terminal can either indicate that it has no data to send; indicate that it has data to send to the CP, in which case the message is immediately sent; or if the terminal is turned off, do nothing (so-called time out). If the CP does not receive a response from a polled terminal after a brief period of time (usually 50 to 150 ms), the CP assumes the terminal is inactive and goes on to poll another terminal. The computer may remember that a terminal is inactive and not poll that terminal as frequently. If either the terminal or the CP detect an error condition (i.e., incorrect VRC, incorrect LRC, improper format or data character, the fact that the transmitter was turned off mid-message, etc.), an error condition will be declared. If the terminal declares the error condition, the CP will retransmit the message. If the message is not correctly acknowledged by the terminal after several retransmissions (typically six tries), the CP will go on to another terminal. It is assumed that the terminal will request the data again at some later time. If the CP detects an error, it will simply repoll the terminal to obtain the information. Again, if the information is not correctly received after several attempts, the CP will go on to another terminal assuming that the information will be available at a later time. The OCLC protocol is basically a link level protocol and is not readily compatible with commercial communication network offerings.

Although there may be carrier present on both the inbound and outbound circuits at the same time, it should be observed that because the CP polls and then waits for a response, user data is never present on both circuits at the same time. The OCLC terminal protocol is for that reason said to be logically half-duplex.

The OCLC terminal network, which consists of over 230 circuits at the present time, is sometimes referred to as having a "star" topology. In fact, the topology of each circuit is more accurately described as having a "tree" topology, and since both inbound and outbound loops are used, it possesses a "double-tree" topology. These topologies are illustrated in Figure 4. The tree structures usually radiate from the CP in a star-like arrangement, and sometimes the trees are unbalanced in the sense that there might not be a branch on each side of the trunk at a given location in a balanced manner. Also, the branches may themselves have branchlets. The OCLC network

is not hierarchial, however, since, regardless of the location of the terminal (leaf) in the network (tree), it always communicates directly with the CP and only with the CP.

As previously indicated, the circuits OCLC employs have the capability to carry at least 3150 baud in each direction simultaneously. This presents the opportunity, using a sophisticated modulation technique like quadrature partial response signaling AM, to encode 4 bits in each symbol. It should therefore be possible to send data at rates up to 12,600 bps over these circuits. If it were possible somehow to divide this capacity in such a way as to run four separate 2400 bps FDX circuits over one Bell 3002 circuit and then separate the four different circuits at the modem, taking only 9600 bps of capacity (i.e., less than 12,600 bps), this might be advantageous on long circuits from a cost perspective (even using expensive equipment). In fact, this can be done (called mutliplexing), and OCLC uses time division multiplexing (TDM) techniques to divide up the capacity on the basis of time and operate not only four 2400 bps circuits, but also the associated four 110 bps telemetry channels over a single Bell 3002 circuit (i.e., 4 x 2400 bps + 4 x 110 bps = 10,040 bps). This is done on selected routes when it is geographically applicable and cost justified. It should be noted that from both the CP's and terminal's point of view, this process is totally transparent, and there appear to be four totally independent circuits (and their associated telemetry channels).

Signals take a finite, albeit short, period of time to travel from one end to the other end of a circuit (so-called propogation delay time). The OCLC terminal protocol causes the CP to wait until a message of response has been received from a terminal, during which time no additional traffic can flow. Should the propogation delay become significant (i.e., about one-half second when the nearly 90,000-mile-round-trip distance by satellite is considered), the efficiency of the protocol is substantially degraded.

5. D-116 to Tandem Links. The line protocol used between the network supervisor (NS) and the D-116 CPs is a FDX synchronous protocol called the OCLC Data Link Control Procedure (DLCP). It employs a double numbering scheme wherein, generally speaking, each message (block) sent from one computer to another contains a number representing the data block being sent and a number representing the last valid block received. Recovery from a data transmission error is made by the retransmission of all data blocks following the data block in which the error was detected. This type of scheme is employed in IBM's SDLC, DEC's DDCMP, and the CCITT-X.25 HDLC protocols. The protocol is not bit oriented; all data sent is a multiple of 8 bits. There is no data transparency mechanism which allows bytes containing arbitrary 8-bit patterns (even if a pattern corresponds to a control character). Rather, all text data sent is limited to 7-bit ASCII characters, although provision is made for interpretation of 7-bit characters as data within certain control fields (i.e., address fields, etc.). The other bit is a parity bit (VRC). A longitudinal redundancy check (LRC) byte is used as a parity check on each block of data sent.

This type of protocol is often called a primary-secondary protocol to emphasize the fact that there are two independent simplex circuits between the two computers which carry data in each direction simultaneously and independently. The protocol is therefore logically FDX. Also, because of the nature of the protocol, one computer does not have to wait for a response from the other computer before it can send a subsequent block of data.

The communications facilities consist of 4-wire (i.e., 2 x 2-wire twisted pair), point-to-point circuits. Short-distance (so called short-haul) modems are used. The circuits are FDX operating at 50,000 bps (50Kbps) in each direction. The computer to modem interface conforms to the EIA-RS-232-C standard.

6. LCP to NS Link. The communications link(s) between the LCP and the NS utilize the Tandem-provided EXPAND software. EXPAND is an extension of the Tandem GUARDIAN operating system. Its components include the network control process (NCP) operating the Tandem defined END-TO-END protocol, network line handlers, and network monitoring programs.

The NCP (i.e., network layer of the protocol) establishes intersystem connections, maintains network-related system information and routing information, determines the best path to other systems, and monitors and logs changes in the status of the network connecting the Tandem systems. The END-TO-END protocol is a Tandem defined packet-switched protocol for exchange of data between systems. The protocol guarantees data integrity from sender to receiver regardless of intervening systems. OCLC uses only point-to-point communications, and hence, no intermediate systems are involved. Packet-switched protocols will be given a more general treatment later in this report.

The Tandem system offers two network line handlers; namely, direct connect and CCITT-X.25. The direct connect line handler is used at OCLC to manage the FDX link between the two systems. OCLC does not use the X.25 capability.

The data link protocol is a Tandem implementation closely related to high-level data link control (HDLC). This is a high-speed, synchronous, primary-secondary, FDX protocol similar to the DLCP protocol discussed earlier. A primary distinction is the fact that HDLC (in addition to being a well documented standard protocol) is a bit-synchronous rather than byte-synchronous protocol. Although the data is sent by 8-bit bytes, the control process enables total transparency (i.e., not necessarily 7-bit characters) and error recovery as well as detection through the use of a technique called "zero-bit insertion." This facilitates the transfer of non-textual data (i.e., data files, software programs, etc.).

The communications facility between the NS and the LCP consists of two 4-wire links (i.e., a 2-wire data loop and a 2-wire timing loop), one each for every primary-secondary link. There are eight physical wires for each bi-directional link between the NS and the LCP. Each physical link operates at 56Kbps, FDX. There are four

physical FDX links between the NS and the LCP for an aggregate bit rate of 224Kbps in each direction. Each link is a direct implementation (i.e., point-to-point wire connection) of a limited subset of the EIA-RS-422-A interface standard.

7. RCP to NS Link. The NS to RCP communication link is identical to the NS to LCP link with the following exceptions. There is only one 56Kbps FDX link instead of four as implemented on the NS to LCP link. Also, because the RCP is located in Atlanta, Georgia, a point-to-point wire connection is not possible. OCLC has installed a 56Kbps AT&T-provided digital data service (DDS) digital (as compared to analog) communications link between Dublin and Atlanta. The DDS requires a CCITT-V.35 electrical interface, while the connection to the Tandem equipment conforms to the EIA-RS-232-C interface standard. Therefore, OCLC utilizes an EIA-RS-232-C to CCITT-V.35 interface converter unit at each location between the AT&T and Tandem equipment. OCLC also operates a separate AT&T-provided 3002, 4-wire FDX circuit in parallel with the DDS circuit to support the telemetry channels. The 3002 channel is operated at a nominal 9600 bps rate and supports 12 individual 110 bps diagnostic channels through the use of multiplexing techniques. This is accomplished by first multiplexing the 110 bps asynchronous channels, four at a time, using three asynchronous to synchronous statistical multiplexers operating at 2400 bps on the synchronous side. These three 2400 bps channels are subsequently multiplexed onto three of the four available 2400 bps synchronous channels of a 9600 bps TDM multiplexer and placed onto the 3002 channel. Of course, the equipment is required at both ends, and the fourth 2400 bps channel is currently used to attach a remote operator's console located in Dublin to the RCP.

8. Tandem to Sigma Links. Communications between the Tandem (i.e., DBP01, DBP02, and NS) computers and the Sigma computers is accomplished using a set of programs collectively referred to as the Tandem-Sigma Protocol (TSP) programs. This is not truely accurate because TSP is not a protocol in and of itself, but rather is a set of programs which provide the services of the various levels of protocol to the application processes resident in the various Tandem and Sigma computers. At the highest level on the Tandem computers there is a program called the Data Base Link Interface (DBLI) which provides all services necessary to enable the applications programs to communicate with the link level protocol supervisor program called ENVOYACP (ENVOY Advanced Communications Program). ENVOYACP is a Tandem-provided program which provides the link level protocol management and can utilize either the High-Level Data Link Control (HDLC) protocol, IBM Synchronous Data Link Control (SDLC) Program, or the ANSI Standard X3.66-1979 Advanced Data Communications Control Procedures (ADCCP) protocol at link level. OCLC has chosen to use the HDLC option. The characteristics of HDLC have been previously discussed. The functions of DBLI and ENVOYACP are performed on the Sigma computers by a program called CPXXX (Communications Program XXX, i.e., CPNS, CPDBP01, CPDBP02, etc.) depending upon the link involved. For purpose of this discussion, these programs are identical. Obviously, the link level protocol must be the same (i.e., HDLC) on the Sigma equipment as well.

The physical links are the same as described for the NS/LCP (i.e., the same subset of EIA-RS-422-A utilizing point-to-point twisted pairs for both data and timing signals) with the exception that only one FDX link (actually two simplex links) is utilized between each Sigma and the respective Tandem computer, and the loops are operated at 146Kbps instead of 56Kbps as previously noted.

Network Analysis System

OCLC operates a minicomputer-based network analysis, control, and diagnostic system completely independent of and from the host and communications processors. Each slave (i.e., terminal related) modem is equipped with a special microprocessor-based diagnostic and control module. The remote microprocessor-based systems monitor the communications links and perform control and diagnostic functions under control of the central analysis system. Some of the functions performed include monitoring of modem and line error conditions, analog and digital measurements at the various modem interfaces, and remote control of the various switches, etc., on the modem.

Through the use of frequency division multiplexing techniques (FDM), the analysis systems take advantage of the fact that OCLC uses only 2400 bps (or 1200 baud) of the 3150 Hz bandpass of the Bell 3002 channel. A sub-carrier (sometimes called a "corner frequency" carrier), or carrier of a different frequency than that used to carry the user data (i.e., sort of like another station on the AM radio band), is used to communicate between the central analysis system and the slave modems using a FDX, asynchronous, 110 bps, FSK modulation technique.

The network analysis system, operating in parallel with the user communications system over the same facilities, enables the network operations staff to monitor and control the terminal telecommunications network with minimal interference with ongoing user operations.

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ECONOMIC AND TECHNICAL FACTORS

Cost of Computing

The cost of computing has diminished dramatically over the past two decades. The cost of processing one million bits of data for transmission has decreased from more than ten dollars in 1960 to about one-tenth of a cent in 1980, a ten-thousand-fold decrease. During the same period the cost of transmission facilities also decreased, but not nearly as rapidly. In 1960 the facilities required to transmit one million bits cost about one dollar, while in 1980 the cost was nearly ten cents, a ten-fold decrease.

Over the past twenty years computing costs have fallen from about ten times transmission costs in 1960 to only one-hundredth of the transmission cost in 1980. In comparison to transmission costs, computing costs are presently nearly negligible. Computing power is routinely incorporated in modern networks in quantities sufficient to assure maximum utilization of the much more costly transmission facilities.

Transmission Costs Versus Circuit Capacity

Cost per unit of data transmitted over telecommunications facilities is not constant, but rather decreases significantly as the circuit capacity increases. Table 2 relates the cost per unit of data as a function of circuit capacity for several AT&T-provided 1000-mile facilities of various capacities. All circuits are private line facilities. Circuits of 2400 bps or greater are digital, while the slower circuits are analog in this comparison.

TABLE 2

FACILITIES COST VERSUS CAPACITY *

Capacity (bps)	Monthly Costs **	Cost/bps/Month
75 bps	$1103	$14.71
150	1401	9.34
2,400	1298	0.54
4,800	1515	0.32
9,600	1865	0.19
56,000	7311	0.13

* 1000 Mile Circuit
** Interstate Services Rate Digest

Most modern networks attempt to bring together and concentrate network load for transmission over high capacity facilities where possible, particularly when longer distances are involved.

Response Time Versus Capacity

Another benefit of higher capacity circuits is less network-related delay and, hence, better response time. A typical outbound transmission on the OCLC network is about 600 characters long and takes about two seconds to transmit at 2400 bps. The same message would require only one second to transmit at 4800 bps, or only one-half second at 9600 bps if this were possible. Also, interfering messages are dispensed with more promptly at higher rates, thus the message can be transmitted more promptly contributing to better response time.

Utilization Versus Capacity

As more and more circuits are concentrated (i.e., as compared to multiplexed wherein the capacity is simply divided) onto a higher capacity facility, the effective overall line utilization can be increased (see Figure 5) while holding response time constant. This result can be demonstrated using "queuing theory," and the interested reader is referred to a text on that subject. This is yet another reason why modern networks tend to incorporate computers into the network (i.e., to accomplish concentration).

Investment Cost of Transmission Facilities

Transmission media can be categorized as either terrestrial or satellite, each having different economic characteristics. Satellites are not sensitive to terrestrial distances (i.e., once the satellite is in place the circuit costs the same whether it is across town or across the ocean). The investment cost of a terrestrial circuit increases at a rate directly proportional with the distance covered. All facilities investment costs are particularly sensitive to economies of scale, and per circuit costs typically vary by a factor of 10 to 100 as the number of circuits increase. Table 3 shows the investment cost for a typical 1000-mile new circuit using various types of facilities in 1970. Estimates of these costs in 1980 are also given.

Efficiency and Line Capacity

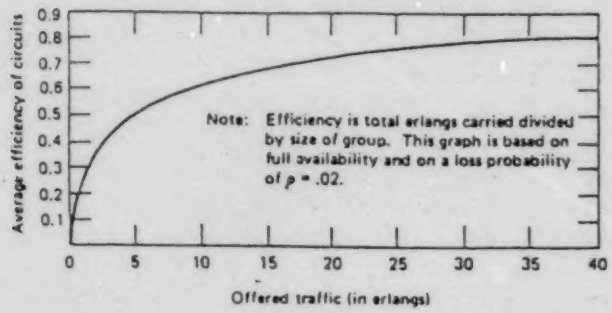

FIGURE 5

Telecommunication System Engineering: Analog and Digital Network Design, by R. Freeman. Copyright © 1980. John Wiley and Sons, Inc. Reprinted with permission of John Wiley and Sons, Inc. All rights reserved.

Long Distance Communications Usage Trends

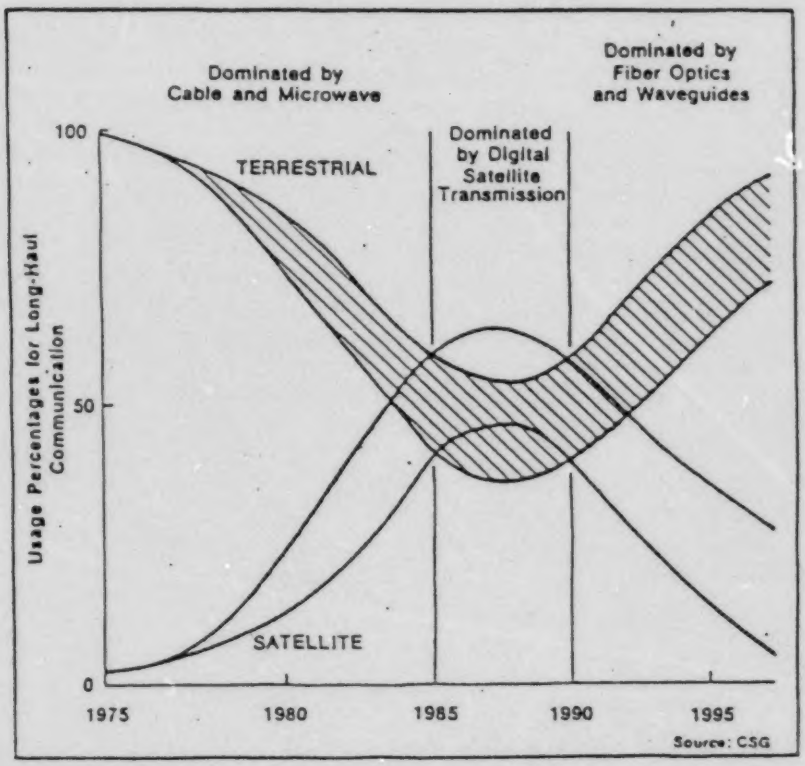

FIGURE 6

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TABLE 3

FACILITIES INVESTMENT COSTS

Facility	Number of Circuits (millions)	(1970) Investment Cost/1000 mile Circuit	(1980 est.) Investment Cost/1000 mile Circuit
Wire pair	0.1	$200,000	$360,000
microwave	1	20,000	36,000
Coax cable	10	8,000	14,000
Waveguide	100	2,000	4,000
Satellite	- *	6,000 **	2,000 **
Light fiber	10,000,000	N/A	[0.04]

* Approximately 6,000 circuits in 1970 and 24,000 circuits in 1980
** Satellites are distance independent

The conclusions to be drawn from these trends are that economies of scale will continue to be of great importance in determining costs, both now and in the foreseeable future, and the current costs of technologies greatly favor deployment of satellite to meet new demands for facilities; however, longer range, fiber optics clearly will present an even more favorable cost alternative, and construction of fiber facilities is presently gaining favor. Figure 6 shows the best current forecast for technology utilization over the foreseeable future. It should be noted that satellite is predicted to dominate during the 1985 to 1990 period, while terrestrial is expected to regain dominance after about 1990.

OCLC Network Cost Trends

Table 4 relates the average OCLC network costs on the basis of terminal hours over the past several years. For purposes of this analysis a 40-hour week is assumed, although not all terminals are in use for 40 hours and many terminals are in use for more than 40 hours. The figures are also given in constant dollar amounts.

TABLE 4

PER TERMINAL COSTS USING THE OCLC NETWORK

Fiscal Year	Telecommunications Cost/Term./Year	Cost Per Term./Hour*	GNP Deflator**	Adjusted Cost Per Term./Hour***
1976/77	$1544	$0.74	132.11	$0.74
1977/78	1422	0.68	139.83	0.64
1978/79	1346	0.65	150.05	0.57
1979/80	1445	0.69	162.77	0.56
1980/81	1644	0.79	177.36	0.59
1981/82	1656	0.80	193.58	0.55

* Based upon 40-hour work week (system is available 87 hours)
** Implicit price deflator - GNP (1972 = 100)
*** Constant dollars using GNP deflator (CPI = 52.1% while GNP = 46.5% for the same period)

Analysis of usage experienced during the month of April 1982 indicates that, using minimum TYMNET rates, the equivalent service to OCLC users over TYMNET would have resulted in an hourly per terminal communications cost of $4.28/term./hour. These numbers would seem to indicate that although network compatibility with public data networks would seem to be advantageous, total reliance on them would seem to be imprudent, at least at the present time.

Summary

With computer costs small in comparison to transmission costs, and decreasing, and with advantages in efficiency, response time, and cost with utilization of high speed (i.e., high capacity) circuits - particularly over longer distances - it is not surprising that use of processors within networks has increased in popularity. Even where processors are not incorporated into the network, more and more processing power is being deployed at the host as well as through the use of more powerful terminal devices in order to help defray the costs associated with transmission - the more costly resource.

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and computer signals for the most part). These strategies gave rise to the various WATS and private line service offerings as substantially discounted rates and such promotional activities as "telemarketing," etc.

Present Environment Within the Telecommunications Industry

With the 1981 Resale and Sharing decision, AT&T essentially lost its nearly total control on the long distance market. Although prior to this ruling some corporations, etc., had used private lines to facilitate long distance calling between offices, etc. This had not contributed to a substantial loss of revenue to AT&T, particularly in light of the additional revenue gained by these services. So-called resale common carriers (RCC) are now applying to the FCC for Section 214 certificates of authorization to become basically non-dominant regulated telephone companies at a rate of about two per day.

The typical RCC, upon certification and tariff filing, acquires a unit of equipment called a "switch," leases transmission facilities from AT&T (which may be private lines, WATS lines, Foreign Exchange lines, regular long distance lines, and/or a combination of the above) and/or other carriers (i.e., MCI, etc., which may be microwave, satellite, etc.), connects the switch to the Bell network, and begins to subscribe the service to the general public, corporations, etc. With appropriate technical and marketing management, it is not unusual for an RCC to operate with gross margins upward of 50-60% while being competitive with AT&T, primarily due to the facilities. Specialized common carrier rates are usually even lower since they must compete with the discounted Bell rates on like facilities.

TABLE 5

PRICE COMPARISON FOR 100 MILE (INTERSTATE) CIRCUIT

Carrier	IXC	Term.	Loops	Total
AT&T	$312.20	$ 69.84	-	$382.04
MCI	143.10	70.00	$51.00	263.00
SPCC	105.00	78.88	80.00	263.88
USTS	146.78	102.00	-	248.78
EMI	50.00	52.00	50.00	152.00

The points to be made are 1) other common carriers (OCC) are gaining significant portions (although clearly not a major portion) of the previous Bell-dominated long distance market, 2) the OCCs are experiencing significant opportunities for substantial profits due in part to AT&T discounting on private line, WATS, and like services, and 3) not surprisingly, there is a rush to get into the business.

Beginning about 1960, the television industry had a need for more economically transmitted video signals and saw private microwave as a way to meet the need. As a result, a significant amount of non-Bell microwave facilities were constructed primarily to meet this need. With the economical availability of satellites, much of the video transmission today is via satellite. The shift away from microwave has left a significant resource in underutilized microwave capacity, which, through the use of modern technology, can be readily adapted to carry telecommunications signals. This is important to note since it is a factor which tends to drive the cost of long distance transmission capacity down.

AT the present time, the Bell Operating Companies furnish their local access services for resale of all but AT&T's interstate WATS and MTS (long distance) services pursuant to Bell System Operating Companies' Tariff FCC No. 8 (1979), Exchange Network Facilities for Interstate Access (ENFIA). This tariff was filed with the FCC by AT&T in the name of the Bell operating companies.

For more than four years, from 1975-1979, resellers and OCCs received the required local exchange access services for use in connection with their alternative (to AT&T) service by ordering ordinary local business exchange service from local telephone companies and paying the rates established in the local telephone company's tariff for that service. During that period of time, the average monthly charge to such OCCs was approximately $54.54 per local exchange line.

Upon effectiveness of the Interim Agreement on April 23, 1979, the OCCs continued to receive the same local exchange service at a charge increased to $92.17. This charge has since been increased to $183.00.

It is not the intent in this document to get into the technical details of the industry. It is important to note, however, substantial amounts of very sophisticated equipment are commercially available (from Bell as well as other major manufacturers such as Datapoint, Honeywell, etc.). The more sophisticated equipment is basically computer technology - not what is usually thought of as switching technology - and a whole software industry has grown up around the specialized needs of this equipment and the business which owns and runs it (of most importance are routing, accounting, and billing software). Of futher importance is the fact that both voice and data to a wide variety of specifications cannot only be handled by the technology, but can also share common transmission facilities as demands warrant. This can be extremely important for optimum capacity/load management and resultant cost minimization.

Future Trends

Predicting future events is always dangerous at best, but I believe we can look at past developments and draw some likely conclusions. It must be realized that regulatory agencies are subject to political influence and, as such, constitute unusual risk in

making logical predictions. However, the FCC has shown a rather consistent history, with some variation, toward deregulation of the industry and has gone out of its way to foster competition - a trend which I believe will continue - probably with a few set-backs now and then.

First, let us look at what has been happening in the private line and WATS areas. These, we must remember, are discounted AT&T facilities which are now being used in competition with AT&T long distance services by OCCs. It is not surprising that we have seen wave after wave of price increases in these services, and substantial increases to boot. It is also not surprising that AT&T would appear to be doing a less than admirable job of defending its WATS service against attack (ironically by the FCC which has sent the justification back to AT&T no fewer than three times). I think we can safely say that AT&T would like to see these services priced, if not comparable to their price for like services, at least high enough to force the OCCs' price higher than AT&T's when the OCC operating margin is considered. Therefore, I feel safe in predicting we will see a 40% to 60% increase in private line rates over the next three to five years in current dollars. Since IXC is about 60% of OCLC telecommunications cost, and assuming a 5% per annum GNP deflator, I look forward to an increase in our cost rate of about 13% per year over the next three to five years unless we take steps to mitigate this clearly unacceptable situation. Further, I believe we will see at least a 40% increase in our WATS rates if not a complete elimination of the WATS discount structure. We might well see an automatic corporate billing at LDD rates for 800 service from AT&T. These forecasts are very ominous and could result in annual cost increases to OCLC in the three to five million dollar range if they come to pass. I sincerely hope they do not!

Within the elements beyond OCLC's control, that could have an effect upon these rates, are the questions of ENFIA and regulatory protections (i.e., special rates for OCLC via one mechanism or another). The whole question of ENFIA charges is up in the air. If AT&T chooses to pursue ENFIA as a way of elevating the effective operating costs of the OCC, then some relief to the private line rate would be forthcoming following my previous line of reasoning. It is clear that AT&T is moving in both ways at the present time (i.e., increasing both transmission facility rates and ENIFA rates). To date the FCC has not interceded; however, I do not feel that the FCC can defend the substantial differentials which are required, and, as such, eventually will have to come down on the side of the OCC. This may mean some temporary relief for OCLC or more probably some mitigation of the rate of increase, but I do not believe this will be substantial in light of the size of the anticipated increases. In any event, ENFIA would not be expected to persist after the January 1984 Bell Operating Company (BOC) divestiture date.

On the brighter side, continued construction of private facilities by SCCs (including a recent surge in fiber optic facilities), the apparent surplus of microwave facilities brought about by migration of video transmission to satellite, and the growing

satellite availability (although "parking space" in geosynchronous orbit is rapidly being exhausted and future capacity increases will depend upon technology improvement and not more satellites) will contribute to reduce non-AT&T transmission facility costs. This would aid the OCC's operating costs and thus their competitive advantage against AT&T. This would also greatly aid private networks that are technologically prepared to use such facilities and/or share them. The status of OCLC technology currently severely restricts our capability to take advantage of such facilities.

REQUEST FOR INFORMATION

CARNEGIE STUDY ON DISTRIBUTED PROCESSING

RESEARCH LIBRARIES GROUP

Jordan Quadrangle

Stanford, California

June 20, 1983

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Chapter 3

A Preliminary System Architecture

The architecture described in this chapter is preliminary. The most important reason for this is that alternatives posed for important components of the system reflect choices not yet made. Secondly, both data gathering and technical review are not complete. The result of either may be new alternatives or changes to those documented here. Respondents are encouraged to suggest changes to these alternatives or to describe new ones.

3.1 General Assumptions

3.1.1 Continuing Support for RLG's Programmatic Goals

Evolution of RLIN to a distributed processing architecture must not compromise RLG programmatic goals in any way. Sufficient information will be retained and made accessible to assure the proper functioning of the Collection Management and Development Program, the Preservation Program, and the Shared Resources Program. The Shared Resources Program, in particular, will be significantly enhanced by placing a powerful existence- and location-finding 'tool directly in the hands of the scholar; this is not technically feasible in the current centralized system.

3.1.2 Presentation of an Integrated Interface

Initially, local systems may not support all applications described in this document nor all functions within them that are ultimately required. But the local system must allow data maintained and capabilities provided in one subsystem to be accessed in another. For example, circulation or serials control information should be accessible in catalog searching, and catalog searching should be available in acquisitions. The boundaries between different parts of the data base and among various functions of different

subsystems should be seamless. Furthermore, a high degree of integration is desirable between the library system per se and other information resources in use at the institution (e.g., departmental data bases, administrative information centers, A & I services).

3.1.3 Evolutionary Distribution

Movement toward an RLG-wide distributed system will occur in steps over a period of several years. There will be differing timelines in each institution due to funding availability; to the variety of library computing equipment now in use; and to differing institutional plans for local area networks.

3.1.4 The Role of the RLG Central Staff

RLG's central staff role may undergo substantial changes in a distributed environment. In the past, the staff has provided support for the specification, design, development, and operation of computerized library information processing services. The emphasis is expected to shift in the future to include facilitation in addition to product development, particularly in the area of standards, and in the formulation of operational models. Development activities will increasingly tend toward support of wide-area networking and data synthesis and distribution.

3.2 Distributed System Overview

The RLG Distributed System is conceived of as a network consisting of a data resource node located at Stanford, California, and local library nodes installed in RLG member institutions. Each node must be able to communicate with every other.

3.2.1 The Local Library Nodes

The primary role of the local library node is to provide access to the local collection through an on-line public access catalog. It also may support circulation, serials control, acquisitions, and cataloging.

The local library node functions both in the RLG distributed network and in the local network. It plays the role of a gateway. When material cannot

be found locally, search requests are routed elsewhere to be processed. If an item is found, an interlibrary loan request can be sent electronically.

3.2.2 The RLG Data Resource Node

The primary role of the data resource node is to provide a union data base to support the resource sharing programs of RLG. In addition to supporting shared cataloging, the data resource node supports interlibrary loan with location information; supports shared collection development and management with selection and order information; and supports cooperative preservation with records of microfilming decisions.

3.2.3 Regional Nodes

Currently, regional nodes appear unnecessary for the RLG distributed network. RLG will move to a distance-independent communications system within the next several years. Replicating data at yet another level and staffing the regional nodes would add significantly to total network cost.

3.3 Distribution and Placement of Function

This section explains the current RLIN network. It describes the migration of function into local library nodes as the linkages become operational.

3.3.1 Current Centrally-Supported Functions

RLIN currently supports catalog searching on a data base containing over seven million bibliographic records and two million authority records. Cataloging is the primary activity, at a level of over 1.6 million titles per annum. Acquisitions ordering, receipt, claiming, canceling are supported, but fund accounting, invoicing, and disbursement are not. Current level of use for acquisitions is 800 thousand titles per annum.

A relatively new service, the Interlibrary Loan Subsystem, allows requests to flow back and forth between borrowing and lending institutions. The data base supports this activity by providing bibliographic descriptions for the requests and location information for request routing. Current ILL activity is 109 thousand requests per annum. As the collection management and

development program progresses, and as the data base is enriched with location information resulting from retrospective conversion activities, ILL use will undergo a dramatic increase.

An authority control system that will perform real-time validation of designated headings in new catalog records will be available in 1985.

The RLG central computer is an IBM 3081 Model D with sixteen million bytes of main memory. The operating system is MVS; the timesharing system is Stanford University ORVYL. The terminal communications network is supported on four PDP 11/44 front-end computers under RSX-11M and Decnet. The system supports nine transcontinental 9.6KB backbones that each break into four 2.4KB circuits at the remote end. Each 2.4KB circuit handles between fourteen and eighteen polled terminals. The number of terminals currently on the network exceeds 600. The data base is stored on nine IBM 3380's with over two billion bytes each.

3.3.2 Current Locally Supported Functions

Most locally supported library automation in RLG institutions currently consists of stand-alone circulation systems. Various on-line public access catalogs are presently being evaluated, and one institution is in the process of installing an OLPAC. A growing number of RLG members have produced specifications for an integrated local system, a trend that has been observed and reported on previously. [2] [3]

Two RLG members currently operate locally developed full-function integrated systems: Northwestern University and The Pennsylvania State University. Both institutions support all technical processing functions, circulation, and an OLPAC. Penn State has nearly completed a retrospective conversion, and Northwestern has begun a selective retrospective conversion effort to enhance access to the collection.

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2. De Gennaro, Richard. "Library Automation & Networking: Perspectives on Three Decades", Library Journal, April 1, 1983.

3. Matthews, Joseph R. "The Automated Library System Marketplace, 1982: Change and More Change!", Library Journal, March 15, 1983.

3.3.3 Augmentation of Local Function Over Time

Over the next several years, member institutions can be expected to augment current local processing capabilities by adding component subsystems or by acquiring an integrated system. It seems unlikely that components or entire systems will be acquired in the future, however, unless those systems support inter- and intra-nodal linkages as described in this document. Given those linkages, RLG encourages its members to move toward a full-function local system that supports an OLPAC, circulation control, serials control, acquisitions, cataloging with authority control, and interlibrary loan.

3.3.4 Residual Processing Support from the Data Resource Node

RLG has a two-tiered membership structure in which smaller specialized institutions participate in subject-related programs without assuming the burden of full membership. These special members, because of their generally small size, may find the idea of a local system unattractive, both for programmatic and financial reasons.

In addition, RLG provides services to a number of other libraries through a broker arrangement with CLASS (California Library Authority for System Services). These institutions may also wish to continue using centralized RLIN services longer than larger RLG member institutions.

Some percentage of RLG member institutions intend to continue using the central RLIN services for at least the next eight years, developing locally only those functions not supported centrally.

For these reasons, current central services will continue to be provided for the forseeable future.

3.4 Distribution and Placement of Data

This section describes the logical structure of the current RLG data base, defines a mechanism for its distribution, and explores the post-distribution data structures in the data resource and local library nodes.

3.4.1 Current Structure of the RLG Data Base

The current logical structure of the RLG data base is shown in Figure 3.1. The circles represent entities; the arcs symbolize binary relationships among the entities. The picture does not represent physical file structure. The entities and some major relationships are described below.

- **Local Bibliographic Description.** Each cataloging user of RLIN maintains an individual bibliographic description of an edition of a given work held by the institution. The descriptions conform to U.S. MARC formats for books, serials, maps, films, and music. Associated with each description are location- and copy-level holdings statements.

- **RLG Bibliographic Description.** If any local bibliographic description exists, the one having the most complete cataloging and content designation becomes the RLG master description. An institution identifier associates the master and local descriptions. This association may indicate that the institution holds the work; that it has ordered it; and/or that it has microfilmed or will microfilm the work.

- **Order.** When an item is placed on order, the order information is appended to an existing local bibliographic description. If a description does not exist, then one is derived either from the master or from another local description; or a brief description is entered, and later upgraded or replaced by a record conforming to RLG standards for completeness. Selection decisions are also recorded here.

- **Heading.** Currently, the RLIN system supports a search-only file of headings that conform to the U.S. MARC format for authorities. RLIN will not support validation and control until sometime in 1985. The structure described here will exist after the implementation of heading validation and control. Logically, most headings will be part of a resource file, to be used for authority work and validation. In addition, any heading that has validated a record will be given a "controlling" status.

- **Interlibrary Loan Request.** Interlibrary loan requests are stored in the RLIN data base, and are transferred between institutional "mailboxes" as transactions move back and forth between borrowing and lending institutions. Associated with each request is a bibliographic description, a requesting institution, a lending institution, and local call number/location.

- **Special Data Bases.** Special data bases contain descriptions of materials for which no MARC format exists, but which have importance for some

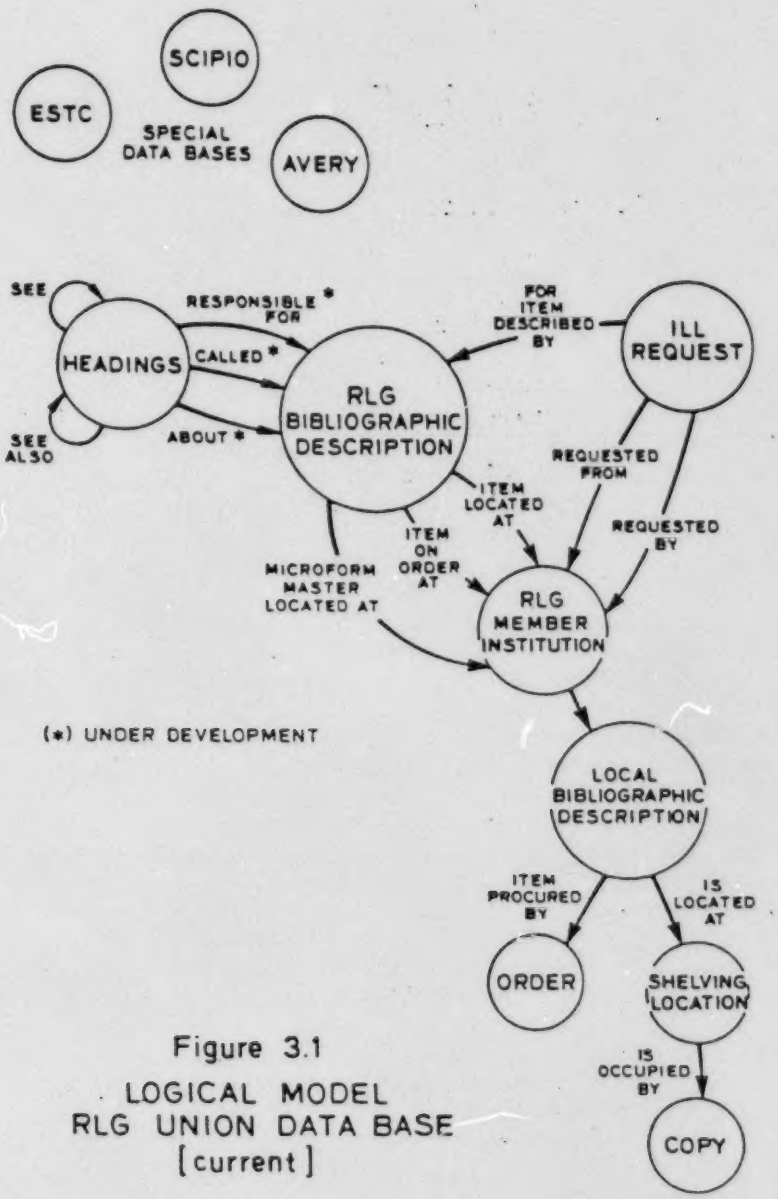

Figure 3.1
LOGICAL MODEL
RLG UNION DATA BASE
[current]

segment of the RLG constituency. Currently three such data bases are supported centrally: Eighteenth Century Short Titles, produced by the British Library, augmented with North American holdings; SCIPIO, a data base of art sales catalog descriptions of interest to museums and art libraries; and the Avery Index, which provides analytic-level information for periodicals in art and architecture.

3.4.2 Data Distribution via Subset Migration

Data will be distributed by migrating institutionally owned subsets into the local nodes, institution by institution, at times chosen by each member. This migration is described in more detail below.

- **Orders.** If an RLG member installs a local acquisition system that supports both procurement and fiscal functions, order information in the central data base will be sent on tape to be converted and loaded into the local data base. The central data base will, however, continue to reflect outstanding orders and selection decisions for that institution. Subsequent orders and selection decisions entered in the local system will be transmitted to the central node to allow this information to be maintained.

- **Bibliographic Descriptions.** As member institutions install OLPACs with record maintenance capability, local bibliographic descriptions, access points, and holdings information migrate from the RLG union data base to the local data base. Master bibliographic descriptions remain in the union data base, together with institution codes to indicate holding locations.

- **Interlibrary Loan Requests.** When an institution adopts a local ILL subsystem, its central "mailbox" moves to the local site. An institution's ILL requests are sent directly to its mailbox, whether it resides locally or in the RLIN central node.

- **Headings.** At the time bibliographic description records migrate to a local environment, those headings that control access points within the records are copied and moved also. The remaining copy reflects the new location where the heading resides. Subsequent changes are sent to institutions using the heading. Conversely, any heading changes made locally are reported to the central node.

3.4.3 The Post-Distribution Data Resource Node

Although it is certain that some RLG member institutions will continue to use the data resource node for technical processing, this section assumes complete distribution. Figure 3.2 provides a logical model of data structures supported in the data resource node. The entities are:

- **Bibliographic Description.** This is the master cataloging record for a given work. It has been identified from among all others residing in the network as being most complete with respect to cataloging and content designation. Each RLG bibliographic description contains identifiers to show which institutions hold the work, which have it on order, and which have microfilmed it or plan to do so.

- **Heading.** Headings carry status and location information showing whether and where they are used. Headings that are not in use are retained as resource records. Institutional identifiers also indicate which institutions have employed a particular heading to control entry point information in a local catalog record, so that heading changes can be appropriately forwarded.

- **RLG Member Institution.** Institutional identifiers indicating where the bibliographic description or heading is in use.

- **Special Data Bases.** The special data bases are unchanged as a result of distribution. They continue to be maintained and accessed centrally.

3.4.4 The Post-Distribution Local Library Node

RLG member institutions will move with varying speeds toward the installation and support of a full complement of local application subsystems. This section describes the logical data structure to be supported after all subsystems described in this document are installed at a local node. This data structure is portrayed in Figure 3.3. The entities are described briefly below.

- **Bibliographic Description.** All published U.S. MARC formats must be fully supported, each field in each format. In addition, supplementary local fields (local tracings, notes) and control information (identifiers and level of cataloging and content designation) are carried by the system as well.

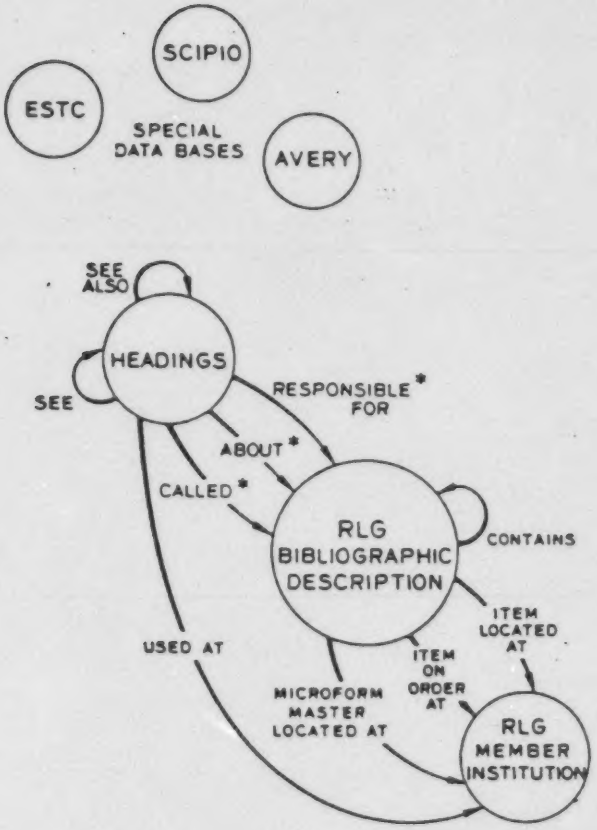

Figure 3.2
LOGICAL MODEL
RLG UNION DATA BASE
[post-distribution]

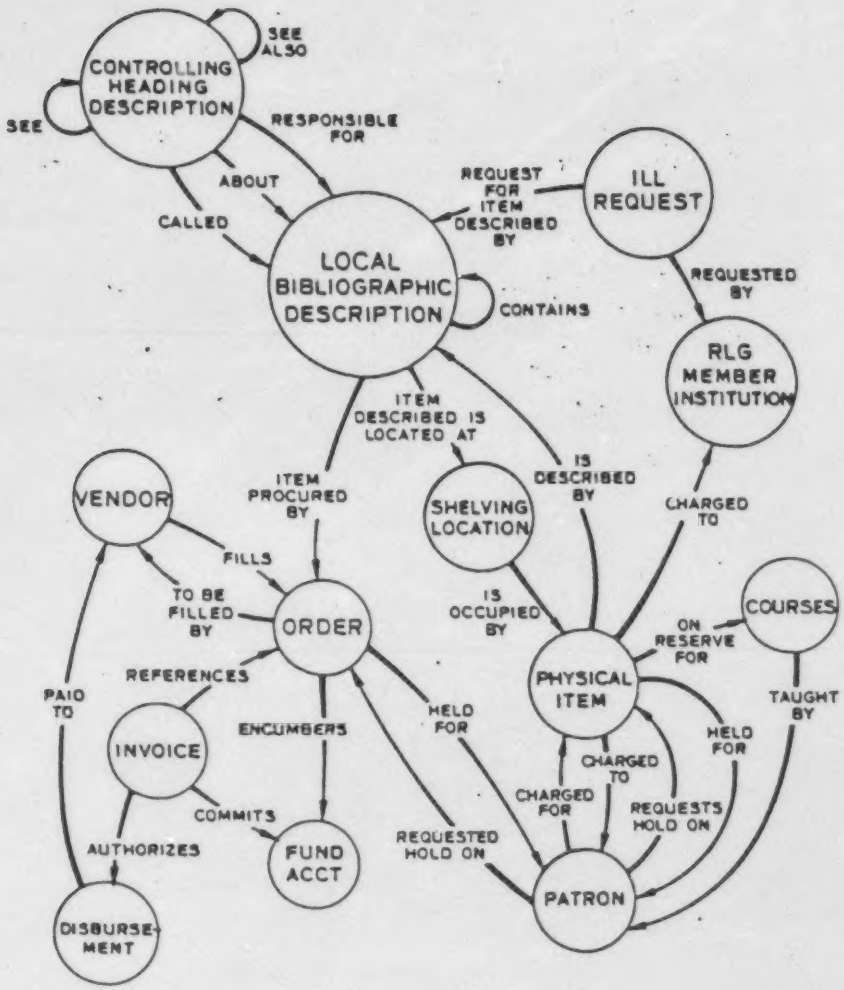

Figure 3.3
LOGICAL MODEL
INTEGRATED LOCAL DATA BASE

- **Shelving Location and Physical Item.** For each title held, the system maintains a general holdings statement and call number; volume holdings, notes, and call number for each location; and notes and call number for each copy in each location. Serials control information is carried at the location level and at the item/piece level. Circulation control information is appended at the item/piece level.

- **Heading.** The published U.S. MARC authorities format is fully supported. In addition, the structure accommodates local cross references, notes, change history, heading change instructions, and appropriate control information.

- **ILL Request.** The ILL message moves back and forth between the requesting institution and potential lending institutions, picking up information as the status of the transaction changes. The message identifies the borrowing and the lending institutions, and provides a forwarding list if the material is unavailable. It contains due date/renewal information, notes, copyright and use information, and requesting patron information. Each request carries a bibliographic description of the requested item, plus local call number/location.

- **Order.** To support the acquisition functions, the system stores and maintains data for orders, requests, the full range of direct accessions, non-action selection decisions, and extended procurements. In addition, the system carries information needed to identify the supplier, to define the pieces of material in question, to properly encumber funds, to claim materials, and to route materials through in-house processing stations. Either a full or a brief bibliographic description is associated with each procurement.

- **Invoice.** The system stores and maintains supplier invoices, including supplier identification, amounts charged, currency conversion data, discounts, funds to be credited, and payment authorization.

- **Fund Account.** For each fund account, the system stores and maintains account identification and descriptive information, allocation amount, encumbrances, and expenditures.

- **Vendor.** The system stores account and address information pertaining to material suppliers. Name and address information is stored for procurements, for invoices, and for claiming, and can be called out in other transactions using an identification number.

- **Disbursement.** A history of payments kept by the system includes check numbers, amounts, dates, invoice numbers incorporated in the payments, and suppliers to whom the payments were sent.

3.4.5 Internodal Data Flow

The previous sections indicate the need to move various kinds of data between local nodes, or between data resource and local nodes. This section explicitly defines the kind of data movement that needs to take place.

DESCRIPTION	TYPE	SOURCE	TARGET
Bibliographic Search	rt(1)	loc	DR(2)
Retrieved Record	rt	DR	loc
Bibliographic Description	ft(3)	loc	DR
Upgraded Description	ft	loc	DR
Removed Description	ft	loc	DR
Order/Selection Decision	ft	loc	DR
Decision to Microfilm	ft	loc	DR
Completion of Microfilming	ft	loc	DR
Heading Search	rt	loc	DR
Retrieved Heading	rt	DR	loc
Heading	rt	loc	DR
Modified Heading	rt	loc	DR
Removed Heading	rt	loc	DR
Modified Heading	ft	DR	loc
ILL Request	rt	loc1	loc2
ILL Response	rt	loc2	loc1

Notes:

(1): rt is a real-time transfer
(2): Data resource node
(3): ft is a batch file transfer

3.5 Three Architectural Models for the Local Node

This section describes three models for the integrated local library system. These models provide an architectural framework within which particular implementations can be categorized.

Regardless of the architecture chosen for the local node, it must fulfill certain design goals.

- **Modularity and Layering.** Layering provides the capability to exchange one component for another without disturbing the surrounding system. A well-defined network interface between the local library node and the RLIN network assigns responsibility for problems and facilitates troubleshooting. In addition, it isolates the local library node from modifications to the RLIN network characteristics, and vice versa. Most of the goals described below include the concept of layering.

- **Hardware Expandability and Flexibility.** The local library node architecture can adapt to changing institutional network configurations. It allows for the addition of capacity and the replacement of discrete components with more cost-effective devices.

- **Software Maintainability and Extensibility.** Software engineering practices employed in the development of local systems should ensure that the software is well-structured, modular, well-documented, and hence, robust, maintainable, and extensible. Use of a high-level strongly typed language such as Pascal is highly desirable.

- **Standardization.** Hardware and software, especially at interconnections between the local library node, the local area network and the RLIN network, conform to ANSI and ISO standards whenever these exist.

- **Reliability.** The local library node is reliable and allows for redundant equipment for those applications demanding little or no down time. Adequate service is available to all RLG member institution locations.

- **Accessibility.** The local library node is accessible to other equipment on the institutional network.

- **Independence.** The architecture allows for independence between the local library and data resource node physical file structures.

- Integration. The local library node architecture allows for the possible integration of currently installed library computing equipment.

A common element of the models is the RLIN network server. The network server provides a standard interface between local node components and the RLIN network. In addition, it serves as a gateway between RLIN and the institutional network. It can also act as a local concentrator for terminals continuing to be directly connected to the data resource node. Depending on the local configuration, it may act as a router among the communicating components of the local node.

3.5.1 A Heterogeneous Set of Discrete Systems

This architecture provides for the interconnection of several discrete systems, each supporting a different application, together with the server described above. The data bases to support each application reside on different machines. Inter-data base searching and record transfer are required to achieve the desired levels of integration. Some terminals are local to each application processor.

Figures 3.4 and 3.5 provide schematic portrayals of two variations on this theme: one that uses a LAN as the means of interconnection, and one that employs point-to-point connections to the network server to allow message transfer among the component systems. In the LAN model, it is possible for terminals attached to LAN terminal servers to access each application system, subject to security constraints. In this model workstations can also access various systems, provided that the proper interconnection protocols are obeyed. The transition from a point-to-point configuration to a LAN is straightforward.

3.5.2 Single System with Multiple Applications

This alternative, portrayed in Figures 3.6 and 3.7, possesses the same characteristics as the first alternative, except that all applications reside in a single system, accessing an integrated data base. The applications processor might absorb the functions of the network server.

3.5.3 Integrated Set of Servers on a LAN

This model employs a set of integrated servers: the network server; one or more servers for each application; one or more terminal servers; intelligent workstations; and a server to support the integrated local data base. This alternative requires a pre-existing LAN in the institution.

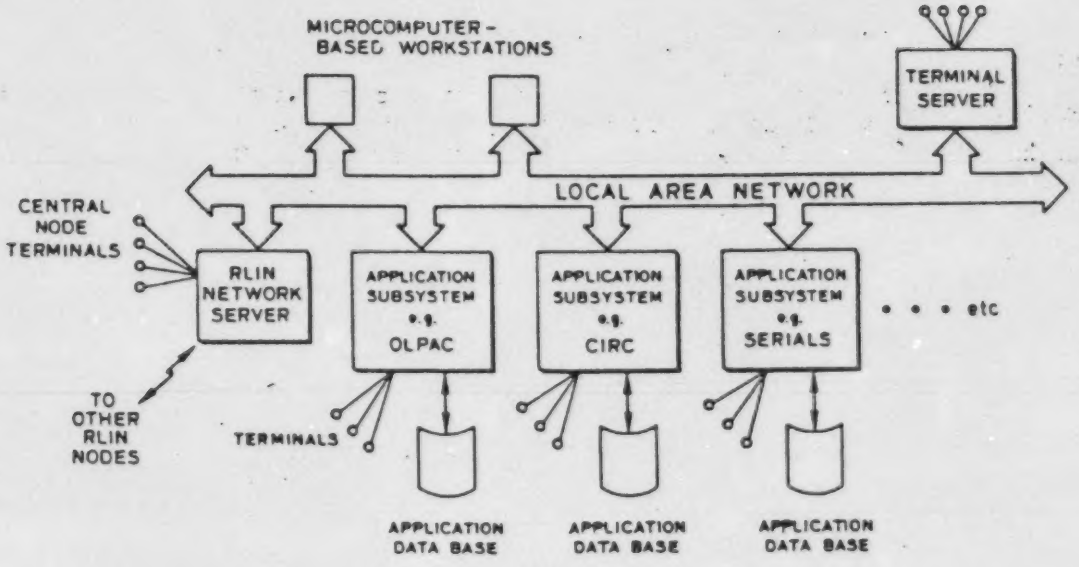

Figure 3.4
HETEROGENEOUS SET OF
DISCRETE SYSTEMS ON A LAN

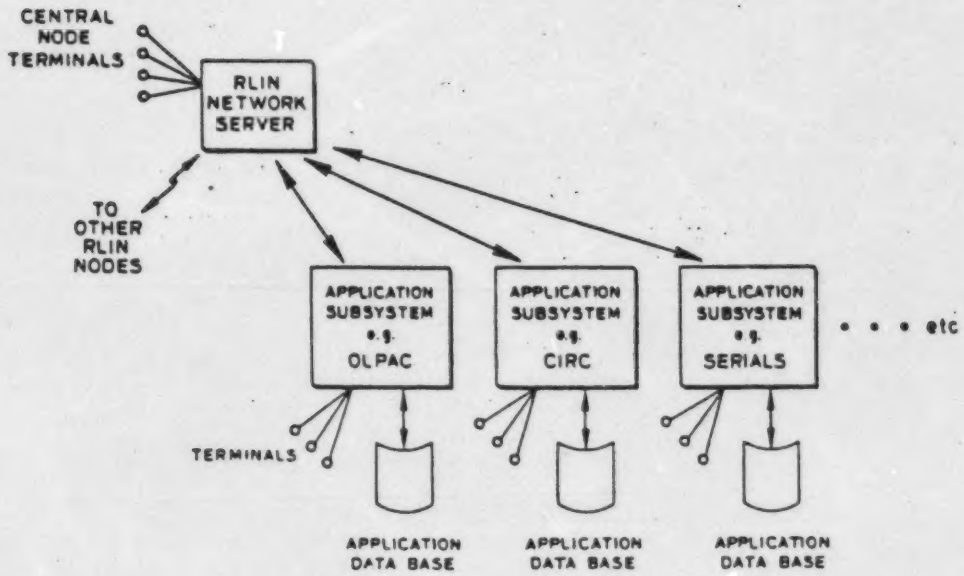

Figure 3.5

HETEROGENEOUS SET OF DISCRETE SUBSYSTEMS CONNECTED POINT-TO-POINT

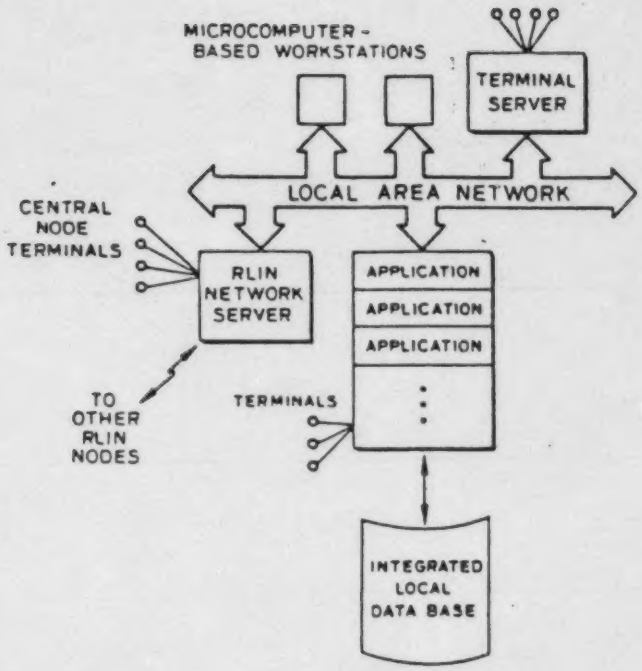

Figure 3.6

SINGLE SYSTEM WITH
MULTIPLE APPLICATIONS
ON A LAN

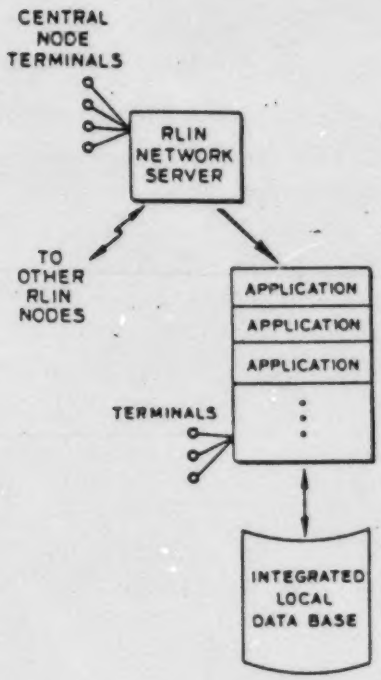

Figure 3.7

SINGLE SYSTEM WITH
MULTIPLE APPLICATIONS
CONNECTED POINT-TO-POINT

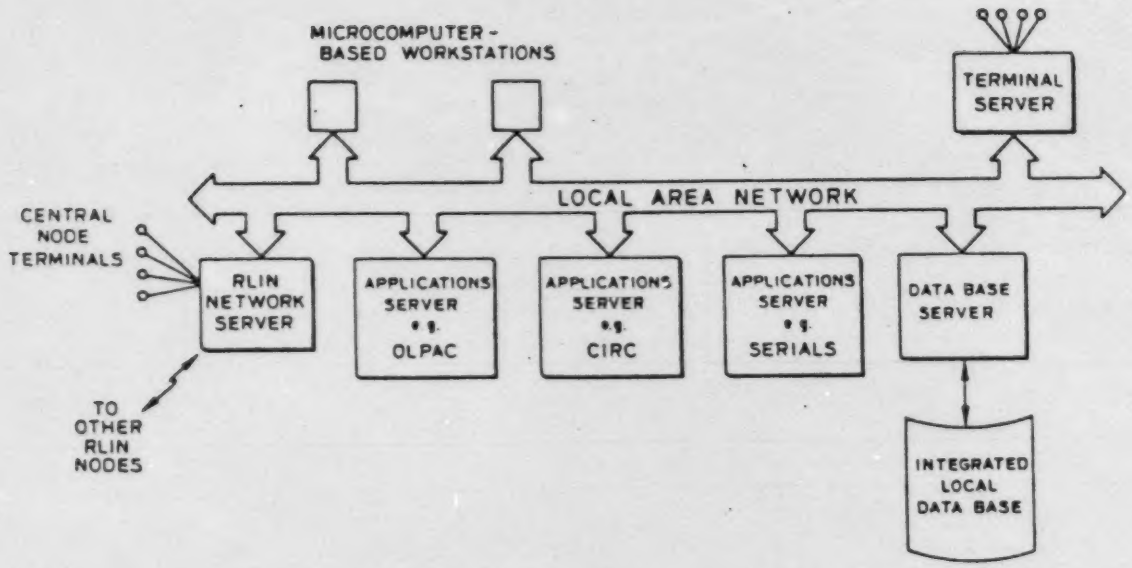

Figure 3.8
INTEGRATED SET OF SERVERS
ON A LAN

Columbia University
in the City of New York

[illegible] NY. 10027

[illegible]

MEMORANDUM April 5, 1983

To: Vice President Patricia Battin, Chair
Dean Enrique R. Arzac
Professor Roger S. Bagnall
Professor Robert E. Canfield
Professor Norman H. Christ
Professor Jonathan R. Cole
Dr. Bruce Gilchrist
Professor Isaac Levi
Mr. Joseph P. Mullinix
Dean Robert E. Pollack
Dr. Philip J. Sharkey
Professor Joseph F. Traub

The University is increasingly dependent on computer-based information processing and related activities. In many disciplines the computer is now integral to research and teaching; in others it will shortly become so. Moreover, the application of computer-based technology to such academic support services as libraries, audio-visual aids, text processing and mail services means that within a relatively short time the academic environment will be wholly permeated by computer-based processes. All this is occurring in a period of rapid technological change, with hardware, software and communications capacities growing rapidly and the expectations of our colleagues and students increasing as well.

Although different parts of the University are currently participating at different rates in what has fairly been called the information revolution, eventually we shall all be fully involved. Communications and information technologies are transforming scholarship, education and the very structure of knowledge. What we do about these developments may well determine our future standing as a university.

In view of the ubiquity, complexity and importance of the issues involved, I am appointing a Presidential Task Force on Information Processing to identify Columbia's future needs for computing, communications and support services and to devise a University-wide strategy to meet those needs. In addition, the Task Force should recommend a mechanism for continued University-wide planning for our information processing environment.

In devising its strategic plan, the Task Force should take account of Columbia's unique structure, its decentralized decision-making processes, its financial constraints and its physical limits. The strategy should be sufficiently broad to permit the University to take advantage of future technological change, but should be sufficiently specific to guide operational decision-making. The Task Force should address such topics as:

--The nature of the present and future technological environment at Columbia
--Networking and communication requirements
--Centralized vs. decentralized computing architectures
--Access to libraries and data bases
--The financing of information services
--The nature of planning processes

That list is obviously not exhaustive and you should feel free to address any issue you regard as pertinent to your task.

I would like the Task Force to submit a preliminary report by December 31, 1983, with a final report to follow, preferably before the end of the 1983-84 academic year. I know that these are demanding deadlines, but even during the course of the Task Force's deliberations the University will have to respond to specific needs and opportunities. We will not, however, consider any major redirection of our information processing efforts until you have completed your work.

I am grateful to each of you for agreeing to undertake this important task.

Michael I. Sovern

SCHOLARLY COMMUNICATIONS IN THE 1990S AND BEYOND

A Strategic Assessment

of the

Library and Computing Functions

of

Columbia University

July, 1983

OUTLINE

INTRODUCTION AND BACKGROUND

- The age of the book is passing
- So is the image of the computer as "number cruncher"
- The library and computing functions are converging
- Four separate paths of innovation
  - Electronic publishing
  - Telecommunications
  - Personal computing
  - Storage technology
- Need for breakthroughs in joint use
- Unique preparedness of Columbia University

GENERAL PRINCIPLES

- Both plentiful resources and high rate of use are needed
- Access must be as free and open as practically possible
- Fragmentation must be reduced to facilitate access
- The "lesson of the railroads" applies

THE CENTRAL CHALLENGE

- Functional diversification through technical integration

LONG-TERM STRATEGIC OBJECTIVES

- Support of all facets of scholarly communications
- Particular emphasis on the liberal arts and sciences
- Continuing central role for library and computer center
- Revitalized service provider/user relationship
- Flexible approach to possible sources of external funding

ELEMENTS OF AN ACTION PLAN

- The information center
- Capacity of central computing site
- Local telecommunications capacity
- Individual workstations
- Data and information resources
- Programming systems and general purpose software
- Advanced storage technologies
- Gateway to other systems and services
- Informational literacy
- The research and development center

CONCLUDING REMARKS

- The global village and electronic cottages
- Effective, personal, and humane scholarly communications
- Concentration on information utilization
- Mobilization of Columbia University

INTRODUCTION AND BACKGROUND

The age of the book is passing and with it is passing as well the image of the computer as primarily a machine for "number crunching"; the printed word and computer assisted numerical analysis will endure and even prosper in the new age that is dawning but it is important to take account of the certainty of their diminished roles. When considering library and computing functional support for scholarly communications in the 1990s and beyond it is not only important to acknowledge this fact, it is essential. Until very recently we have gone to libraries mostly to learn what others have had to say about a subject of interest and we've gone to computer centers mostly to try to make sense of data we've collected in the course of our research. Now things are no longer so clear-cut. Soon we won't even have to go to libraries or computer centers and we'll use computers to analyze data others have collected and look to libraries for help in getting what we have to say into circulation without the costs, delays, and other obstacles publishing has come to represent. Academic planners can no longer ignore these changing and crossing roles of the library and computing functions because it is clear that they are manifestations of fundamental trends transforming the infrastructure of the scholarly community.

Significant innovations in information technology have become almost commonplace occurrences on the contemporary scene. Advances in most of the areas concerned have taken place without conscious regard to developments in functionally allied areas. In four particularly crucial areas a host of important breakthroughs soon will be achieved by concentrating on how they

can be made to work together rather than on how each can be separately pushed forward. Such efforts certainly will demonstrate a total information processing power which is only implied at present. They also will illuminate lines of future development currently obscured or assigned inappropriately low priorities.

The four areas in question are: (1) Electronic publishing -- information resources of all description (reference materials, full-text documents, statistical series, etc.) are available in a wide range of machine-processable forms; (2) Telecommunications -- digital networks of great extent and reliability link people with people, people with machines, and machines with machines; (3) Personal computers -- low cost, space-economical but remarkably powerful machines are used by a wide and newly computer-literate public; and, (4) Storage technology -- magnetic approaches provide high capacity and relatively low cost systems and set the stage for video and optical techniques to improve performance by impressive orders of magnitude.

Columbia University is uniquely prepared to undertake a program devoted to (1) bringing these four technologies into a common planning and operating framework and (2) insuring that future developments proceed in a coordinated fashion. By attempting such a program Columbia will improve the environment which supports its scholarly community while demonstrating to others what can be done. This paper presents why this is the case and outlines an action plan by which to initiate the long-term process involved; it is intended to stimulate discussion and many of its sections will be improved on the basis of opinions, reactions, hopes, and fears

learned by this means. It begins with a set of general principles which lead up to the central challenge which motivates the overall endeavor. These remarks also engender an appreciation for the context of urgency in which these deliberations take place: it is through such programs that higher education institutions and their libraries will revitalize their relevance and competencies in the emerging information age of post-industrial society.

GENERAL PRINCIPLES

The wealth or value of a cash economy is not simply a matter of the amount of money which exists in it; the rate at which the money circulates is an equally important factor. A similar principle obtains in the case of information economies; a great wealth of knowledge can exist but a well-endowed information economy can be said to be poor relative to its potential if its knowledge is not widely and rapidly disseminated. Columbia University furnishes an example of such an information economy. The expertise of its faculty is among the highest across a wide range of specialities and the interests so represented are supported by one of the most outstanding research libraries in the world. The "amount" factor of the university's informational wealth has been built over a long and distinguished period; the "circulation" factor now must receive equal attention and technology exists which warrants reasoned optimism as to the likelihood of major improvements in this regard.

The impressive momentum of innovation in information technology is a mixed blessing. On one hand the increasing sophistication of modern information

resources and tools provides opportunities for timely and flexible access to knowledge which were impossible or even inconceivable five to ten years ago. The other hand, though, is that increasing sophistication has brought with it increasing complexity and costs requiring new and sometimes rather specialized skills while taxing financial resources in uncomfortable ways. All too often the combined effect of these developments has been to reenforce the role of money as a prerequisite for access to knowledge. This trend had been a particularly troublesome one and has been generally resisted to every degree possible by scholarly communities in institutions of higher education supported by their research libraries. In these communities the open and free pursuit of ideas is paramount in accordance with the cultural mandate from which they derive their legitimacy. In recent years, therefore, many such communities have rededicated themselves to informational infrastructures which allow discretionary access to knowledge equal to and surpassing that provided by the traditional library. Again, the current state of information technology encourages efforts along these lines.

Very few social agencies have a compelling interest to reduce the fragmentation which characterizes the state of advanced information technologies and services in the contemporary world. Indeed, many actors with predominantly economic motives have a disincentive as long as incompatibility with a competitor could result in increased business upon that competitor's demise. Western society historically has accorded to universities the special role of striving to develop frameworks which harmonize things which on the surface appear to be dissimilar, even fundamentally so. Universities in turn have relied upon their libraries to

provide dependable and comprehensive access to the information resources which need to be marshalled in this regard. For these reasons universities and libraries are ideal settings in which to attempt projects devoted to reducing fragmentation in favor of increasing integration of information technologies and services. Universities and libraries with the combined expertise and resources of the magnitude of Columbia University are in the best position to attempt the most ambitious endeavors of this type.

As many universities and their libraries ponder their future they run the risk of not acting upon what often is called "the lesson of the railroads". By this is meant that faced with changes as major as those faced by the railroads with the coming of the interstate highway system and affordable air transporation there is a tendency to hold ever more firmly to the certain conventional rather than to risk grasping the uncertain unconventional. Columbia University should look with enthusiasm to the era which is emerging from the shaping influences of electronic publishing, telecommunications, personal computing, and storage technology and plan for the reality that the end-result will be a total transformation of the information processing infrastructure which supports its scholarly community. By embarking upon a program of this type the University would achieve major improvements in how its community members interact, how they interact with their library, and how both interact with the world at large. Through steady progress in these regards Columbia University would provide as well a "model experience" for the benefit of other scholarly communities and interested parties and agencies. The revitalization of purpose and activities which will result represents a consequence of inestimable cultural value.

THE CENTRAL CHALLENGE

The single most important feature of the informational infrastructure for the coming era of scholarly communications is concisely said to be "functional diversification through technical integration". All too often in today's world as a user switches from one information resource to another s/he has to switch service providers and access mechanisms as well. At best this requires that users remember and execute multiple annoyingly protracted sequences of system connection procedures and keep up to date with numerous system file structures, organization and classification protocols, and search, retrieval, and information processing languages. The worst case is that specialized equipment or (even esoteric) training is required which is prohibitively expensive or otherwise beyond the reach of the user. The key to an improved situation is to add capabilities (functional diversification) at a faster rate than changes in access mechanisms occur (technical integration). Hardware and software resources must be acquired and in some cases developed with sufficient capacity and flexibility to manage a wide range of information and data resources in a common framework. A number or promising steps in this direction have been made already; Columbia University is in an excellent position to become a leader in the exploration of the limits of the possibilities.

LONG-TERM STRATEGIC OBJECTIVES

In order to suggest how focus can be achieved for Columbia University's efforts within the vast field of attractive alternatives the following long-term strategic objectives have been identified. Some of these are

clarifications while others are decisions which reflect the distinctive character of the University's tradition and experience. Amendments and additions to the list are expected in accordance with discussions of this document and its subject.

* Scholarly communication should be supported in all its many facets. Community members should be assisted with all the tasks covered by authoring and publishing as well as those covered by computational analysis or searches for information in support of their interests. To attempt less than full support would be inconsistent with the goal of the central challenge. It also would not lessen the dependence of scholars, universities, and libraries on publishers and thereby would pass up an excellent opportunity to remedy the unsatisfactory arrangement in which universities support scholars who supply publishers with information which the universities must buy back for their libraries.

* Particular emphasis should be placed upon the disciplines of history, the humanities, and the allied sciences generally referred to as "the liberal arts and sciences". These community members have received much less support and exposure in the natural course of their scholarly pursuits than has been the case with their more technologically involved colleagues. By concentrating upon them the maximum possible impact would be obtained in a variety of disciplines crucial to the intellectual life of the University.

* The Columbia University Libraries and Columbia University Center for Computing Activities have played central roles in the past and should continue to do so in the future. Major transformations in service philosophies and approaches should be effected on the basis of the careful and continuing analysis of library and computing functions in support of scholarly communication. Outreach programs should be designed and implemented and library and computing professionals should become as adept at representing information technology and services as they are at using them.

* The revitalization of the relationship among members of scholarly disciplines and library and computing professionals is an important first step toward preparing the University for a leadership role as regards continued innovation in information processing systems. Attention already is being drawn to a not so distant future in which expert or knowledge-based systems will blend the reasoning powers of artificial intelligence with the factual and heuristic resources of human trainers and users. Such "fifth generation" systems will require intimate collaboration among subject, information, and computing specialists.

* Opportunities for external support of these endeavors should be carefully managed and particular attention should be paid to taking account of the variety of beneficiary motives which occur in an effort of this scale. Computer and other system manufacturers and suppliers are inclined to offer support through favorable terms or even gifts of their products while philanthropic foundations are inclined to offer

either restricted or unresistricted cash grants. Some beneficiaries want to assist with equipment expenditures while others focus on data and human resources. Fund raising campaigns should be cognizant of and sensitive to all of these differences and probably others as well. Every effort must be made as well to identify sources of continuing operational support in addition to sources to help with initial outlays.

ELEMENTS OF AN ACTION PLAN

The development of an action plan which specifies how exactly to reform the library and computing functions of Columbia University to support scholarly communications in the 1990s and beyond is properly left to a time after which interested parties at the University have had an opportunity to review, comment on, and contribute to this paper. Only then can the required levels of detail and committment be achieved. Nevertheless, a number of action plan elements can be identified in advance and these provide an analytic outline until a more comprehensive treatment is available.

* An organizational entity should be created to provide the sorts of new services which are to be made available to community members and to provide focus and leadership as regards the effort as a whole. A very attractive approach is furnished by the information center model of the IBM Corporation. This model has achieved an impressive degree of acceptance in the business community but is relatively untried in academic communities particularly in so far as scholarly rather than

administrative concerns are at issue. It is based upon an assumption which is precisely appropriate: "... if provided with proper education, technical support, usable tools, data availability, and convenient access to the system, users may directly and rapidly satisfy a portion of their ... requirements ...". The implementation of IBM's information center model would not only provide Columbia University with a needed organizational entity it would produce as well a wealth of information of tremendous use to other higher education institutions.

* The capacity of the central computer site should be carefully analyzed in light of the impending conscious effort to expand activity by many orders of magnitude and to concentrate on the sorts of tasks which make heavy demands on input/output rather than strictly computational resources. Current plans call for the installation of an IBM 3083 for administrative including library uses in the fourth quarter of calendar year 1983 and this will undoubtedly provide adequate capacity to support pilot or demonstration projects yielding important planning data. Within three years, though, and probably sooner rather than later, it is reasonable to expect that an upgrade to a machine of at least the size of an IBM 3081 will be required. It may even be decided to house informational computing on one or more machines of its own, perhaps in the range of IBM 4341s; this would result if system tuning, security, accounting procedures, and other considerations indicated it. Large volumes of direct access and mass storage devices will be needed; a requirement on the order of magnitude of 50 billion bytes within five years would not be surprising. Furthermore, it is absolutely essential to integrate these resources into the local inter-system network for both message and pass-through access. 57

* Local telecommunications capacity should be carefully scrutinized as well. The existing twisted-pair network has served and will continue to serve the University well. The installation of data-over-voice technology implemented through the existing telephone system provides the surest and quickest way to achieve a compatible network with many times the capacity of the existing one as measured in terms of numbers of nodes. The relatively limited capacity of this network in terms of bandwidth (which determines the amount of data which can be communicated per unit of time) means that it is an interim technology with a life span perhaps as brief as three to five years. During this period video and optical storage techniques are expected to mature with a significant amount of information becoming available in one or the other of these new formats. One of the impacts of this development will be radically increased telecommunications demand as more and more large volumes of data constituting full text (including even art, perhaps) are broadcast by electronic means. Until the likelihood of this is high enough to warrant operational planning every effort should be made to improve the twisted-pair technology already in use throughout the University.

* A range of individual workstations should be designed and supported and a very active program of placement must be thought through and implemented. There will continue to be a role for single-purpose and rather limited capability workstations such as IBM 327X and "dumb ASCII" CRTs and no matter what level of sophistication is achieved in workstation design care must be taken to fully support "common denominator" terminals such as these. An intensive campaign to promote

standalone personal computers as workstations should receive particular attention. By this means members of the community could be provided with the sort of dependable and cordial access to computing resources which is an essential building block in the functional chain which constitutes the emerging mode of scholarly communication. Although such computers also can and will be used as simple workstations when connected to remote resources via the telecommunications network they more likely will be used to control the "blocked data transfers" (file down- and up-loading) characteristic of distributed computing arrangements and to manage the sorts of sophisticated communications protocols which are expected to be perfected during the next three to five years. Full information and consultation should be available to enable interested individuals to attempt to employ in this manner whatever personal computer s/he has. The University's attention, however, should be focussed on a fairly limited range of products in order to insure that some personal computers are fully supported and developed in concert. At Columbia University the most attractive alternatives in this regard are the IBM PC, the DEC Rainbow and the DECmate 2.

* An impressive array of data and information resources should be gathered or developed and made available through the information processing infrastructure. Paramount among these are three resources which are essential to effective and complete access to the monographic holdings of Columbia University Libraries: (1) cataloging data currently stored in the Research Libraries Information Network; (2) cataloging data prepared by means of "retrospective conversion"

projects devoted to covering monographic holdings obtained prior to the establishment of the Research Libraries Information Network; and, (3) authority control data by which spelling, word order, format, and other forms of search term filtering can be accomplished together with computer-assisted cross-referencing and prompting for search strategy refinement. Also of critical value are a selected number of bibliographic files which provide access to periodical literature and which experience has shown attract enough use to merit local processing with resulting economics of scale. Less easy to generalize about but of no less value for researchers are the sorts of statistical and textual compendia which are playing an increasingly central role in modern scholarship. Across the entire range of data and information resources important questions of priorities and financing will have to be addressed in light of selection criteria and guidelines. This policy apparatus should offer to every degree possible an expeditious and rational decision as to which resources will be acquired at community expense and which will be at individual expense.

* A most imposing challenge is presented by the selection of programming systems and general purposed software. The familiar resources of this type will be needed so that users can have access to a stable operating environment which manages machine resources in a reliable way and which contains language processors and utility packages adequate for do-it-yourself computing projects. Special attention should be paid to software products attuned to information processing per se and major investments of time and money likely will be required in this area. Text editors, document formatters, and data base management systems

provide examples. Software which enables on-line patron access to the contents of the Library's catalog is a second area. In addition to these are a number of other utilities such as key-word in context and book indexing programs. Every effort should be made as well to obtain a general-purpose search/retrieval system to enable access to files of periodical information or whatever other similar bibliographic files community members would endeavor to create; examples of widely known products of this type are STAIRS, SPIRES, and BRS/SEARCH. As will be the case with data and information resources selection criteria and guidelines for software should be carefully developed and publically reviewed so that decisions about community versus individual expense can be handled as rationally as possible. Furthermore, given the use of personal computers as individual workstations steps should be taken to acquire software for loan through Library mechanisms or for use on workstations housed in the Library.

* Tremendous technological advances are soon to be made in the manner in which documents are stored and this will have major ramifications on how they are distributed. For years libraries among other concerned parties have endeavored to preserve and economically distribute and store documents on film media such as microfilm and microfiche. These techniques have been widely adopted even though they have evident and serious drawbacks with the human factors of viewing their contents and the technology of reconstructing paper-copy versions. Current research and pilot project testing on a large scale indicate that video and optical disk technology not only will provide the sought-after advantages of endurance and space economy but will provide as well

arbitrarily high fidelity in reproduction. Some versions of this technology even capture color and others are digitally-based and thereby capable of interacting with telecommunications and information processing systems in general. When publishers and printers began to employ computer-assisted production techniques using magnetic media it was a safe bet (that far too few people made) that sooner or later libraries and scholars would have to become adept at handling information in electronic formats. The preconditions surrounding video and optical disks are the same. Every effort as soon as possible should be made to enhance the preservation activity of Columbia University Libraries with this new technology and to provide a base of operational experience in order to be ready for the era of new storage technology which is on the horizon.

* Scholarly communications are very distinctive in their cosmopolitan nature and this is a reflection of the overwhelming degree to which they are organized according to professional rather than institutional structures and dynamics. This requires that the informational infrastructure of Columbia University should provide "gateway" access to cooperating information processing systems housed at other institutions and agencies. Providing gateways of this type is first of all a telecommunications problem and this results in a heavy weight being placed on the cost side of the cost/benefit scale. The economic value of the benefit side unfortunately too often has been seen only in terms of the individual scholar rather than h/h institution. But it is clear that computer-mediated resource sharing and electronic mail and conferencing afford noteworthy cost control advantages let alone yield

benefits as regards coordinated and simplified capital planning and improved public relations. Columbia University should continue to develop such gateways and the cooperative programs on which they depend in as active a fashion as possible. In addition to establishing telecommunication links, moreover, efforts should be made to provide software to harmonize command language and other system differences to assist community members with keeping up to date with the wide range of resources available through such links. Software design of intelligent system gateways and associated "applications level" standards are very attractive research and development areas in which Columbia University could make major contributions.

* As language influences the expression of thought so strongly as to make language and thought methodologically inseparable, the technology of scholarly communication and the contents of scholarship too are intimately related in a fundamental way. The implication of this is that as the infrastructure of scholarly communications is transformed in the revolutionary way projected by this paper a conscious effort should be made to assist scholars to learn how to use and to benefit from the new technologies. The term "computer literacy" has come into use in this context but "informational literacy" is more appealing. Some attempt should be made to expose community members to computers and other modern information technologies and to explain their components and principles of operation. More important, though, is exposure to and explanation of knowledge resources and structures and the information processing systems which manage and access them; as experience with automobiles, telephones, and televisions has shown when

people know where they want to go, who they want to talk to, and what entertainment they want to have they are perfectly well prepared to learn how to use and live with the tools that help fulfill their desires. Columbia University should institute a wide-reaching program devoted to informational literacy containing curricular elements as well as orientations and workshops for officers and faculty. The program should be flexible and provide numerous tracks in order to account for the varying levels of preparedness and styles of learning which exist. Careful attention should be given as well to incentives by which to encourage participation.

* A research and development entity should be established and care should be taken to insure its autonomy as regards the operational entities of the University's information processing system. This agency should conduct routine and special studies of community attitudes in order to produce data needed for evaluation and planning. It also should be able to undertake studies which provide technological and functional forecasts or which report upon the experiences and thoughts of others as regards an interest of Columbia University. Finally, it should be provided with sufficient resources to enable it to acquire and then develop newly emerging technologies in order to gain concrete local experience to assess their potential. In comparison to the other entities cooperating on the University scene to provide an informational infrastructure for scholarly communication, the research and development entity should have a pronounced detached attitude. This is warranted by its dedication to working on and bringing into focus functions, technologies, and service arrangements which are five

years or more in the future. It should not be totally isolated from operational concerns as the operational entities should not be totally isolated from research and development but the direction of the emphasis should be clear and scrupulously maintained.

CONCLUDING REMARKS

Marshall McLuhan, among many other commentators, has noted that electronic media are bringing about a "global village" in which communication is universal and instantaneous. The image is more apt now for scholarly communication than perhaps has been the case at any previous time. Scholars want to communicate with each other irrespective of national boundaries and geographic distances. They also seek interactive communication rather than the one-directional kind so characteristic of news and entertainment boradcasting. An image related to that of the global village which also has great suggestive power is the "electronic cottage": a workplace in addition to a dwelling in which a resident can pursue h/h career without the need to commute daily to a centrally-located factory or factory-like office. The world envisioned by notions of the global village and the electronic cottage is an appealing one because it promises that advanced information processing technology will usher in an era in which scholarly communication will become both more effective and more personal and humane than currently is possible. The key to reaching this future is to concentrate on improvements in information utilization with the same urgency and fervor that information production has received over the last twenty years. Breakthroughs of this type clearly are both needed and possible. Columbia University has the community of scholars and

the traditional library and computing resources needed to undertake an ambitious long-term development effort of this type and thereby to improve the environment of its community while offering guidance to others as to how they might proceed. Significant increase in the value of the information economics represented by scholarly communications would result and by this means important cultural goals would be furthered. In order to be sure to benefit Columbia University should initiate its planning and fund raising projects as soon as possible because it is in the next year to eighteen months that the leaders in the developments are being sorted out. Columbia clearly has something distinctive to offer and the University should be mobilized to step forward and do so.

UNIVERSITY OF CALIFORNIA
at
SAN DIEGO

UCSD TELECOMMUNICATION SYSTEM PROJECT

REQUEST FOR INFORMATION

FINAL REPORT AND RECOMMENDATION

UCSD
TELECOMMUNICATION
TECHNICAL SUB-COMMITTEE
MAY 1983 75

SELECTED PAGES

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in kit

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EXECUTIVE OVERVIEW

Communication of information, whether by voice, computer or television has been one of the most rapidly developing technologies of the last decade. The demand for information is the driving force behind this development and few other organizations are confronted with such a degree of demand for information as is the University.

This campus has endeavored to exploit communication technologies within the constraints of facilities that were never intended for such applications. Now the campus is faced with the absolute necessity of resolving the problem of communications or severely limiting its ability to survive as an effective source of information.

The two key problems that must be resolved are the lack of adequate support facilities and the ability to provide cost effective communications.

The first problem, facilities, has two elements:

--Transmission capacity is finite for a given collection of communications paths of a certain type. The existing facilities have insufficient or non-existent transmission capacity to support current or future requirements. The present voice configuration has been adapted for the transmission of low speed digital data on a limited number of lines, but is unable to support high speed digital data or video transmission.

--Insufficient conduit and tunnel capacity exists to support expansion of the existing transmission facilities. Increasing conduit and tunnel capacity would be excessively expensive to implement and maintain, and redundant in the light of present transmission technology.

The second problem, cost effectiveness, has been developing steadily over the last few years. Operating expenses for the telephonic system have been increasing at approximately fourteen percent annually for a total seventy percent increase over just the past five years. The "CENTREX Technoeconomic Analysis Report" (April 1983), prepared by the Medical Center's consulting firm Natel & Company, has projected future annual rate increases at seventeen percent. (Cost Comparison Chart

pages 24-25) A simple calculation using the current cost for even a single telephone will produce some shocking results. Consider thousands of telephones and the problem of providing a cost effective system becomes apparent.

A new information communication system is essential if the campus is to continue its mission in research, instruction, and public service. Although voice traffic will continue to be a primary user of the communication system, the rapid expansion in the use of small distributed administrative systems, on-line library resources, and personal computers used by researchers and students will make digital information exchange the other primary activity on the system in the near future.

A Campus Task Force was established to study the problems outlined above, and soon after, a technical subcommittee was formed for the purpose of making an evaluation of specific technical requirements as well as a review of available technology that may satisfy those requirements over the next ten to fifteen years. This is the final report of that subcommittee.

The subcommittee has taken into account the full spectrum of communication dependent activities at UCSD, including existing requirements, projects currently under development, applications that are in demand but not being offered, and future developments that clearly need to be addressed.

A Request For Information (RFI) specifying the current status of communications on the campus as well as the future requirements for communication capabilities was used to initiate the review process. The RFI was sent to fifty relevant communications companies of which seventeen responded. The subcommittee analyzed their responses as well as the "Systemwide Telecommunications Report" and the "UCLA Telecommunication Project". From this review an integrated and focused perspective of requisite communications technology for UCSD was developed. The RFI is attached to and should be considered part of this report.

RECOMMENDATION 1

It is recommended that the Telecommunication Services Department proceed with the development of a RFP for a voice/data integrated switching system to serve the campus voice, and limited on/off-campus data transmissions.

RECOMMENDATION 2

Telecommunication Services Department should begin installation of a multi-cable

broadband cable system with the ultimate goal of installation of a cable termination in the service entrance and riser system of each significant building in the University both on the main campus and SIO. The installation should proceed in four states:

--Stage 1 would consist of determining the University's present and future data requirements, engineering studies and electrical design of the system;

--Stage 2 would consist of installation of a localized test-bed cable facility to support the Academic Computing network, Administrative System networks, and the two major video production functions. The test-bed would provide the necessary testing and evaluation to further develop the network;

--Stage 3 would consist of opportunistic installation of cable in conjunction with the digital switching system; and

--Stage 4 consists of planned completion of the cable networks.

A broadband, CATV-type coaxial cable network will become one of the primary communications conductor systems within the University for data and video. It has been determined that a number of vital software requirements will have to be defined for adequate functioning of the network. These requirements will be analyzed by the Technical Subcommittee data representatives and documented in conjunction with the installation of the test-bed. The total cable network should materialize in conjunction with the digital switch project. However, an apropriate test-bed facility for initial stages of computer, data and video facilities should be undertaken immediately. Opportunities that arise to coordinate the rest of the network with the digital switch project should be taken in order to minimize the cost of development.

Certain initial costs for engineering, cable system design and test-bed installation must be borne as part of the overall telecommunicatons project. The technology of broadband cable communications requires a total-system design and balance. Consequently, engineering studies and a long-term plan (two to three years) must precede initial construction.

RECOMMENDATION 2A - Alternate

The University should undertake to negotiate a joint venture with a local CATV cable

company for campus-wide installation of the multi-cable cable network as a part of the mutual supplier and end user relationship.

The time frame for installation of community cable would have to coincide with the Telecommunications Project overall time frame.

The University should take advantage of the local cable company contracts for engineering, construction, and electrical installation of community networks in order to obtain the most favorable costs. Initial contacts with one company indicate that benefits may be gained from such a strategy.

RECOMMENDATION 3

The University should appoint a Local Area Network (LAN) steering committee, at the appropriate level, to provide coordination and policy development for the LAN common carrier. The responsibilities of the committee should include the following:

1) development of plans and policies in all areas of LAN common carrier applications;

2) integration of major operational networks for the LAN general service concept;

3) monitoring and evaluation of centralized and decentralized communication services to ensure efficiency and conformity to University LAN common carrier policies; and

4) review of capital and operating expenditures for information transmission requirements to insure they comply with established LAN common carrier policies.

The committee will function as an "interdisciplinary" group in the definition of need, formulation of plans for development, and evaluation of potential. Continuation of these joint efforts will ensure that the LAN common carrier network is utilized to its capacity and not substituted by redundant services.

JUSTIFICATION

Two urgent needs for communications are not being well served at this time: video

and high-speed data. The distribution of instructional video has been virtually non-existent due to lack of adequate transmission facilities. Data communications are serviced principally by use of the Pacific Telephone Company telephone system wiring network; with attendant high cost, (i.e., line installations, monthly lease, modems and line drivers, purchasing and installing, etc.); limited performance capabilities, and limited pathways it provides. As computing and information technology become more deeply a part of the day-to-day activities of faculty, students, and administrative staff, the current data communication network facilities will become more inadequate and inappropriate, and will fail to serve the needs of the University.

It is apparent the information obtained as a result of the RFI, that telephonic communications systems available with the introduction of the new third generation digital switches will support voice, switched data (up to 56,000 KBS), packet switching (up to 1MBPS) in a non-blocking mode, in a reasonable and cost effective manner. However, they will not address either video or sustained high-speed data communications.

The information supplied to the University by telecommunications vendors clearly indicates that solution of video and sustained high-speed data communications requirements will be by means of a cable system separate from the telephone system. There are two types of cable systems available--baseband and broadband. The baseband carries about 3% of the capacity of a broadband and can be carried as a "Channel" on a broadband system. Baseband systems can be compatible with broadband systems and may be useful in intra-building networks. However, broadband cable systems are clearly superior in the institutional context. As a general rule a broadband single ½ inch coaxial cable with a 300 MHZ signal will support 30 video circuits. When configured in an intergrated video/data mode it will support 25 video circuits and 10,000 19.2 KBS data circuits. A video channel requires a 6 MHZ bandwidth, however, a 6 MHZ channel will support 2,000 19.2 KBS data circuits or provide a carrier for intercampus 5 MHZ baseband (ETHERNET) circuit. The broadband frequency spectrum can be allocated in any configuration best suited to support University requirements.

Simply stated, broadband communication facilities provide for additional capabilities not provided by telephonic digital communication facilities. We are making this point in order to substantiate the importance of availing this superior capability .

to the University. The additional benefits of a broadband communication network are numerous and will provide flexible support for high-speed computing, video, and general purpose carrier far into the future. Video and data communications capabilities are anticipated to become a major component of the overall activities of the University. Segregating video and a major portion of data communications in a broadband system will result in major cost avoidance in future years within the telecommunication system. (Reference Cost Comparison Chart pages 24-25)

Development of the integrated Digital PBX and Local Area Network is a key element in the long-term plan for development of computing at the University of California San Diego. Failure to proceed in a timely manner with this development will have a seriously detrimental effect on the orderly, efficacious and cost-efficient implementation of the computing plan and the activities it supports.

BACKGROUND

The Systemwide Telecommunication Task Force requested a campus task force be formed to conduct its own telecommunication study. The campus Task Force study was to determine the needs of UCSD and select a state-of-the-art telecommunications system to support campus voice, data, video, environmental control, security and safety requirements. The study was to place special emphasis on a new telephone system, and a campuswide local area network (LAN) for high speed data transmission and video distribution. Additionally, the selected campus system would need to be capable of interfacing with a Systemwide Telecommunications Network selected by the Systemwide Task Force. In order to provide adequate technical assistance, and to meet the campus Task Force charge, a Technical Subcommittee was formed. It is composed of the following members:

NAME	TITLE	DEPARTMENT
Lynn Abbott	Manager, Marine Technical Group	Marine Technical Group SIO
Dan Asmann	Systems Manager	Center for Astrophysics & Space Sciences
Earl Balch	Systems Manager	Library
Virgil Brown	Director, General Services	UC Medical Center
Harvey Campbell	Manager, Telecommunication Services	Telecommunication Services
Charles Cox	Managing Producer-Director	Office of Learning Resources
Jim Madden	Computer Systems Designer	Computer Center

Bob Merryman	Principal Programmer	Administrative Systems
Dr. Richard Moore	Director, Center for Music Experiment	Center for Music Experiment
Ray Pena	Finance Officer	School of Medicine
Dr.Anthony Sebald	Associate Professor	Applied Mechanics & Engineering Sciences
Jerry Shannon	Telecommunications Engineer	Telecommunication Services
Al Shaw	Telecommunications Finanacial Analyst	Telecommunication Services
Dan Sullivan	Campus Media Manager	Media Center Communications
Tom Uter	Senior Development Engineer	Chemistry
Ted Uyeda	Computer Facilities Manager	Data Processing UC Medical Center

The early months of work by the Committee were devoted to study issues which affected 7 principal interests respresented on the Committee.

Academic, Research and Instructional Video Requirements
General Purpose, Telephonic Communications
Administrative Services, Administrative Computing
Instructional Media, Broadcasting
Data Communications and Computer Networking
University Library, Information Dissemination
Personal Computer on/off Campus Access to Campus Computer Facilities

This study revealed that decisions about how and when the University will participate in the new technology have not been predetermined by the present degree of participation, the current level of investment, or the evaluations of the alternative means of participation. An opportunity still exists for the University to determine in a conscious and rational way the manner in which it will utilize the new communications and information technology. The financial consequences of the decisions made by the University will be enormous, constituting significant portions of the budgetary capacity of the institution. Appropriate decisions can save the University millions of dollars while achieving enormous benefits. Less adequate decisions will lead to lesser achievements at greater cost. The University must remain in the mainstream of communications and information technology to survive as a first-rate institution. The most important consequences of the decisions will be their effects on the quality and vigor of the University's research and instruction, the public service programs, and the administration of

those programs. Consequently, great care and energy must be focused on how the University participates.

The leading universities of this country are actively developing extensive and highly coordinated communications and information technology components. In order to maintain and improve its place in reasearch and education, the University of California, San Diego must move vigorously and decisively in this domain.

Presently, there are several principal divisions of the University concerned with communications and information technology. The telephone, radio, data/private lines and microwave facilities of the University operate out of Business Services, with a reporting path through the Vice Chancellor Business & Finance. Computer communications and computer information technology are divided between the University Computer Center and Administrative Systems while reporting to the Vice Chancellor Information Systems and Computing. The video productions facilities of the University are operated in major part by Media Center and the Office of Learning Resources in turn reporting respectively through the Vice Chancellors of Academic Affairs and Health Sciences. Other operational and academic units have major dependencies and responsibilities involving communication and informational technology. Decisions regarding communications and information technology in each academic and administrative unit must be highly coordinated to utilize the University's resources effectively and efficiently.

The work of the Telecommunications Task Force and its Technical Subcommittee is an example of the coordinated action and joint planning that is needed to provide a sound basis for developments in complex, rapidly developing, high-cost technology. The recommendations coming out of the Committee's work do not provide for a single, monolithic solution to all of the communications problems facing the University. However, the recommendations do come out of a careful evaluation of the needs and problems of the University and of the mechanisms whereby the University can satisfy those needs and resolve the problems in a reasonable manner at a reasonable cost.

The Committee developed an integrated and focused understanding of the current and future communications activities and needs for the University, covering a wide range of activity areas, in a wide range of administrative responsibility areas. This understanding is stated as a portion of the RFI and was used to obtain data on the current status of communications technology.

EXCERPT

D-53/000/00
February 15, 1983

YALE UNIVERSITY

ADMINISTRATIVE INFORMATION SYSTEMS PLANS

Organization: University Library

Sandra E. Stone
David L. Weisbrod
Systems Office
Yale University Library
New Haven, Connecticut

Following are brief descriptions of areas in which the library is likely to consider information systems. These areas, while not necessarily of project status in terms of the current computing survey, are areas where the library either is already considering information systems or is likely to consider information systems in the next five years.

The following numerical codes are used here to designate priority:

Code "1" designates top level priority and is assigned to projects of the greatest importance to the library.

Code "2" designates mid level priority and is assigned to projects of less than the most pressing importance, i.e., to projects that might be "put on the back burner" without serious impact on library service and efficiency, if resources had to be diverted elsewhere.

The five projects discussed in the sections that follow have been assigned these priorities (all five are presently being investigated actively):

1 -- Top Level

Catalog Continuation
Serials Control

2 -- Mid Level

Word Processing
Acquisitions
Circulation Control

7.1. Catalog Continuation (Priority: 1)

(1) Project Overview.

(a) Description. We expect that the standard 7.5 x 12.5 cm catalog card, organized into wooden drawers, will be replaced either by the compu r output microfiche (COM) or by the online cathode ray tube (CRT) terminal. Computers have been used at Yale for almost two decades to aid in the preparation of cards to be placed in traditional catalogs; soon for the first time the medium of presentation of the bibliographic data through which the library user gains access to the collections will be changed. This is both an opportunity and a challenge: the opportunity to bring together in one place for the user information about many disparate facets of the library that presently have to be separately researched, and the challenge to build an economical, reliable, flexible system that loses none of the important features of the present catalog mechanism -- to build a system that at least does not decrease, and may in fact improve, the ease with which a user may find what is wanted.

(b) Data Groups. Not yet determined.

(2) Desired Completion Date. The library currently has a Catalog Continuation Committee investigating the continuation mechanism. Their recommendation is due 1983 June 30. A date for the completion of the project (i.e., for placing the new catalog continuation mechanism into public service) has not yet been set.

(3) Project Justification. The existing system of card catalogs has been pushed to its limits. The expense of maintaining the existing catalogs is great enough to sustain our optimism that a computer-based catalog will be competitive in cost -- or, maybe, even less expensive.

(4) Project Assumptions.

(a) Hardware/Software. There is a strong possibility that we will be running an online, interactive catalog on a dedicated computer. If this is the case, we will want at some point to be able to offer dial-in access to the catalog to persons at Yale using their own terminals (both "public" and "private" terminals in the sense used by YCC). We therefore make the assumption that there will exist at Yale a local area network (LAN) of sufficient capacity to accommodate the communications traffic between a large population of user terminals and the library's computer functioning as a "server" on the network. The LAN will also facilitate connecting the library's own ("dedicated") terminals, located in various buildings around the campus, to our computer, wherever it may be situated.

No hardware or software has yet been selected for this project.

A crude, preliminary estimate of the number of CRT terminals that might be required in the libraries for catalog access falls in the range of 100 to 150. These would be dedicated terminals, quite distinct from the population of terminals dialing in for occasional access, referred to in the first paragraph of this item. The number of printers required has not been estimated.

(b) Project Leadership. The work of formulating functional requirements for the catalog continuation mechanism has been assigned to a Catalog Continuation Committee of four members of the library staff. Responsibility for subsequent phases of the work has not yet been assigned; continuing involvement of the Systems Office is anticipated.

(c) Personnel. The impact of the catalog continuation mechanism on personnel requirements cannot presently be predicted.

(d) Other. We assume that the catalog continuation mechanism will be implemented in the context of Yale's continuing commitment to the Research Libraries Group and to its programs, and of Yale's continuing participation in the Research Libraries Information Network.

(5) Interdependencies. In the event of selecting online display (rather than COM) as the medium for our user interface, we will depend on the availability of campuswide digital communications, such as those provided by the LAN mentioned under item 4.a (Project Assumptions -- Hardware/Software), above. If the LAN were not to be available by the time we need it, our per terminal expenses would likely be increased, and we would probably compensate for this by reducing the total number of terminals to be installed.

NETWORK LIBRARY SYSTEM (NLS) PROJECT

University of Wisconsin-Madison

University of Chicago

IBM Corporation

Brief Description of NLS Communications Architecture

The local library node architecture incorporates a mainframe, and one or more Series/1 minicomputers with terminals attached as required. This architecture supports the widest variety in range of sizes of computing. IBM compatible mainframes are available in the widest possible range of sizes. The Series/1 minicomputer is inexpensive enough to replicate as often as required to provide sufficient terminal access ports and distributed processing power.

The minicomputer supports the circulation and online public catalog functions. It is connected via a high speed local area network twin-axial cable ring to one or more other minicomputers serving other libraries at the local site.

The University of Wisconsin-Madison has several dozen medium to large size library collections geographically distributed over several square miles. The communications gateway from the local area network is provided by a minicomputer channel attach connection to an IBM mainframe. The mainframe can communicate to other local or national nodes via standard communications protocols. Communication software permits any CRT in the network to access any other minicomputer in the local node and all functions on the mainframe including inter-mainframe communications. Minicomputers can be connected to the local area minicomputer network via the standard switched network if the distance exceeds 2,500 feet between ring nodes.

8/5/83

Current Public Statement

NETWORK LIBRARY SYSTEM (NLS) PROJECT

University of Wisconsin-Madison

University of Chicago

IBM Corporation

The University of Wisconsin-Madison, The University of Chicago, and the IBM Corporation have entered into a joint project to complete development and testing of the Online Public Access Catalog and Circulation functions, the first phase systems of a transportable Network Library System (NLS). NLS is a state-of-the-art system designed to be used by libraries of various sizes and by library networks. This modular system is intended to include all the functions of a typical academic or public research library although no commitment has been made to develop future modules such as Acquisitions or Serials Control.

The three institutions have common and unique objectives for the project. The common objectives include implementation of the prototype system and a better understanding of what costs, personnel, and IBM hardware and software are involved in developing and operating such a system. IBM's primary interest in the NLS project is to support the universities in library automation development and to expand its own library expertise. The IBM involvement in NLS, however, does not imply a commitment to make any portion of the system available as an IBM product.

The first phase was completed on April 1, 1982 with the successful demonstration of minimum function Online Public Access Catalog and Circulation modules operating on IBM equipment. The complete function transportable network system for those modules will be available by the end of the current agreement in 1985.

The basic structure of the NLS is a central CPU linked to several remote CPUs. The central facility contains the master data base for both the Catalog and Circulation modules with provision for immediate, online update of the Catalog information by authorized technical services personnel. The master data base contains full bibliographic information (LC/MARC and local) and full authority control information, including cross-references. It also contains holdings and piece data for each member of the network.

The Circulation information is revised at the central facility, on a low-priority real time basis, from the online updates recorded at one of the remote CPUs. The Circulation data at the remote CPUs are structured for greatest efficiency to search and update the piece and patron data online. The data at each remote CPU contain information pertinent to the local library of the network which that CPU serves.

Similarly the Catalog module located at each remote CPU will provide online bibliographic information pertinent to the local library served by that CPU or, at the option of the library, to a union catalog for a group of cooperating libraries. The data and its indices are structured for efficient response to a wide variety of search techniques available to the library user. The online Catalog data at each remote CPU will be updated only from the central CPU at weekly, monthly or quarterly intervals depending on the individual library's preference.

The system conforms to most of the CONDOC requirements for Online Public Access Catalogs. Feature highlights include word and phrase access to both bibliographic and authority data, support for SEE and SEE ALSO networks among bibliographic and authority records, saving and reuse of search results by combining sets with new query terms, unlimited use of boolean operators, full and brief record displays of bibliographic and authority data, and access by a variety of additional control numbers.

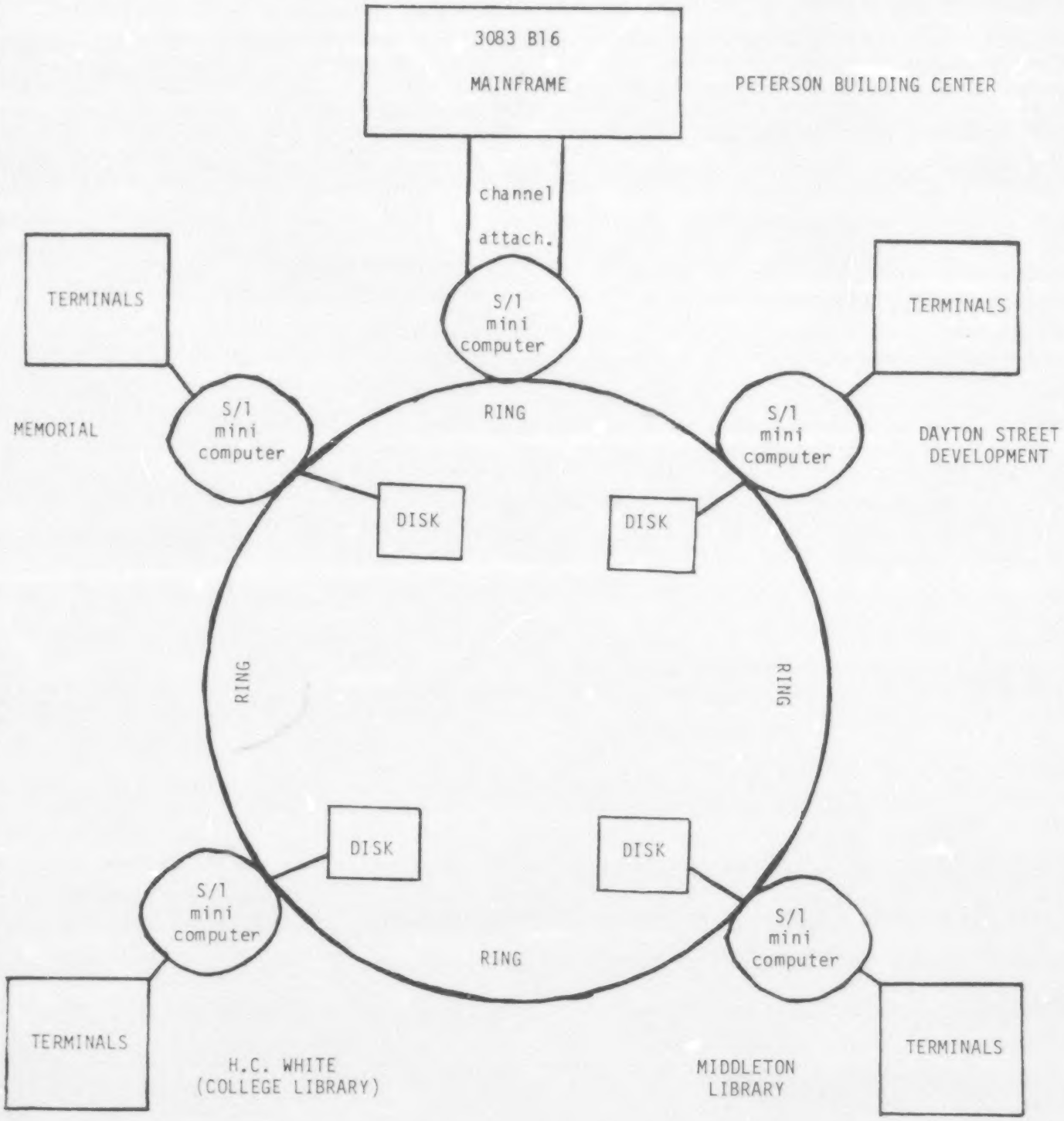
Networking capabilities will enable a user connected to a remote CPU to access the central CPU and any other remote CPU in the network. A high speed local area network ring connects the central and nearby remote CPUs. Standard telephone switched network communications is available for distant remote CPUs.

Currently, the NLS team is completing production installation of the NLS Online Circulation and Online Public Access Catalog modules at the UW-Madison College library. The next installations are scheduled at the UW-Milwaukee and UW-Madison's Memorial Library.

5771C

Network Library System Architecture

UW - Madison



PLAN

Peninsula Libraries Automated Network

September 1983

AUTOMATED LIBRARY CIRCULATION SYSTEM
COMMUNICATION SYSTEM CONFIGURATION

Planning and budgetary estimates for the communication system supporting the automated circulation system was prepared by representatives from the County of San Mateo Communications and Data Processing Divisions.

Configuration options explored included exclusive use of telephone company lines and combinations of telephone lines and microwave channels already in place for County-wide civil service purposes.

In order for line-of-sight microwave transmission to provided to all 30 library locations in the network, one additional microwave tower had to be constructed at an estimated one-time cost of $46,000. However the on-going cost between a exclusive telephone network and a telephone/microwave network proved the microwave network to be approximately $12,000 less annually.

After review of the "Automated Library Circulation System Cost of Communication Options" (Attachment A), the Governing Board selected option: Lines C; Modems B2 (or Summary Option D, 2400 BPS).

Having selected the combination telephone/microwave option, costs were refined for budgetary purposes as outlined in "Communication Configuration" (Attachment B) and "Communication Costs" (Attachment C) documents.

The County of San Mateo accepted the responsibility for the installation of the communication network, which occurred in the spring of 1983. PLAN has an "Agreement for Communications Maintenance Services" (Attachment D) with the County for ongoing maintenance and repair. Personnel from the County Communications Division are contacted if communication problems are suspected. All contact with the telephone company is the respon..ibility of this Division in the installation of and service to the network.

While 85 CRT terminals were originally planned in our network, 91 are now scheduled for installation by the end of this year. In addition, 22 receipt printers are installed. A circulation system constraint advises against having more than 4 CRT terminals per line. Several of the communication lines serve two libraries.

Because of proximity to the central computer site, 8 sites are served by telephone lines exclusively. Should costs change to be in favor of a microwave connection for these sites in the future, they could be added to the microwave network at any time.

Lois M. Kershner
Project Director

Member Libraries: Burlingame ☐ Daly City ☐ Menlo Park ☐ Redwood City ☐ San Bruno ☐ San Mateo City ☐ San Mateo County ☐ South San Francisco

25 Tower Road ☐ Belmont, California 94002 ☐ (415) 573-3411

PLAN

Peninsula Libraries Automated Network

September 1983

The Peninsula Libraries Automated Network (PLAN) is a group of eight public jurisdictions in the County of San Mateo that joined together under a Joint Powers Agreement in May of 1982 for the establishment of a shared automated circulation system. These eight jurisdictions, the cities of Burlingame, Daly City, Menlo Park, Redwood City, San Bruno, San Mateo, South San Francisco, and the County of San Mateo, comprise the public library systems in the County of San Mateo, serving a population of 578,000.

Together the libraries hold an estimated 500,000 titles with approximately 1,500,000 volumes. Collective annual circulation to the libraries own residents is 3,700,000. thirty buildings and two bookmobiles house the library's collections.

The circulation system: Geac 8000
- cpu with 512 kilabytes of MOS memory
- three 300 megabyte disk drives
- tape drive
- 300 line/minute printer
- console printer
- 91 CRT circulation terminals; 22 receipt printers
- County microwave communication system

The data base: Presently 180,000 titles
- 110,000 loaded from OCLC and RLIN tapes
- Prospective cataloging: OCLC transferred via online interface; RLIN via tape
- Retrospective records: OCLC transferred via online interface; RLIN directly keyed in brief record format

Organization and Governance Structure:
- Governing Board, each jurisdiction with one vote
- Manager's Review Committee - 5 city management representatives who review budget and contingency allocation
- Project Managers Committee - review and recommend policy to the Board
- Bibliographic Standards Committee
- Finance Committee
- Personnel Committee
- Public Relations Committee
- Project Staff: Project Director, Library Computer Operations Assistant, 2 hourly computer operators.

Finance: $1,154,000 two-year budget
- Operating Agent: County of San Mateo
- Central costs shared by formula (% of total cir + % of volumes + % of population)
- Central one-time costs invoiced upon expenditure; central on-going costs invoiced annually; local costs invoiced semi-annually.
- Annual audit

Member Libraries: Burlingame □ Daly City □ Menlo Park □ Redwood City □ San Bruno □ San Mateo City □ San Mateo County □ South San Francisco

25 Tower Road □ Belmont California 94002 □ (415) 573-3411

-1/19/82

Attachment A

AUTOMATED LIBRARY CIRCULATION SYSTEM

Cost of Communications Options

				Annual Cost
I. Lines				
A. Entirely Pacific Telephone				
$1,401.23 per month for 24 circuits				$16,815
B. Pacific Telephone to County Microwave nearest County Main Library; Microwave to Police Station nearest Library to be served; Pacific Telephone to Library to be served.				
1. Pacific Telephone - County Main to Microwave - $341.64 per month			$4,100	
2. Microwave channels (20)				
$18,000 (distributed over 7 yrs.)		$2,571		
Maintenance of Microwave ($240)		4,800	$7,371	
3. Pacific Telephone - Microwave to Library - $615.97 per month			$7,392	$18,863
C. County Microwave to Police Station nearest Library to be served; Pacific Telephone to Library to be served				
1. Install Microwave at County Main Library - $35,000 (dist. over 7 yrs.)			$5,000	
2. Microwave channels (20)				
$18,000 (dist. over 7 years)		$2,571		
Maintenance of Microwave ($240)		4,800	$7,371	
3. Pacific Telephone - Microwave to Library - $615.97 per month			$7,392	$19,763
II. Modems				
A. 1200 BPS (Asynchronous)				
1. Pacific Telephone				
$1,593.76 per month			$19,125	
Installation (distributed over 7 yrs.)			751	$19,876

2.	County Purchased		
	$425 x 56 (distributed over 7 yrs.)	$3,400	
	Installation $3,000 (dist. over 7 yrs.)	429	
	Maintenance ($5 per month)	3,360	
	Pacific Telephone Station Termination Charge		
	Line option B selected		
	90 terminations @$47.43 = $4,268.70	610	$7,799
	Line option C selected		
	54 terminations @$47.43 = $2,561.22	366	$7,555
B.	2400 BPS		
1.	Pacific Telephone (Synchronous)		
	$5,936.75 per month	$71,241	
	Installation (dist. over 7 yrs.)	954	$72,195
2.	County Purchased (Asynchronous)		
	$800 x 56 (dist. over 7 yrs.)	$6,400	
	Installation	429	
	Maintenance	3,360	
	Pacific Telephone Station Term		
	Line option B selected	610	$10,799
	Line option C selected	366	10,555
C.	4800 BPS (Synchronous)		
1.	Pacific Telephone		
	$8,488.67 per month	$101,864	
	Installation (dist. over 7 yrs.)	1,195	$103,059
2.	Count Purchased		
	$1,600 x 56 (dist. over 7 yrs.)	$12,800	
	Installation	429	
	Maintenance	3,360	
	Pacific Telephone Station Term.		
	Line option B selected	610	$17,199
	Line option C selected	366	$16,955
III.	Dial Up Modems		
A.	Portable Terminals 2 @$800	$229	
B.	Auto Answer 1 @$525	75	
C.	Maintenance	180	$484

IV. Summary

		Annual Cost
A. Pacific Telephone Network and Modems		
24 Circuits	$16,815	
1200 BPS Modems	19,876	$36,691
2400 BPS Modems		$89,010
4800 BPS Modems		$119,874
B. Pacific Telephone Network and County Modems		
24 Circuits	$16,815	
1200 BPS Modems	7,799	$24,614
2400 BPS Modems		$27,614
4800 BPS Modems		$34,014
C. Pacific Telephone; Microwave; Pacific Telephone (Option IB)		
24 Circuits	$18,863	
1200 BPS Modems (County)	7,799	$26,662
2400 BPS Modems (County)		$29,662
4800 BPS Modems (County)		$36,062
D. Microwave; Pacific Telephone (Option IC)		
24 Circuits	$19,763	
1200 BPS Modems (County)	7,555	$27,318
2400 BPS Modems (County)		$30,318
4800 BPS Modems (County)		$36,718

COMMUNICATION CONFIGURATION

Attachment B

Agency	Line#	Total # CRTs/ Line	# Modems/Cost	Modem Mn./Mo.	Microwave Mn./Mo.	PT & T Lease/Mo.
Burlingame Main	11	4	2/1500	6	-	43
* Main/Easton	12	4	3/2250	9	-	55
* Daly City B/JDD	1	2	3/2250	9	20	59
Westlake	2	3	2/1500	6	20	25
Serramonte	3	4	2/1500	6	20	36
Menlo Park	22	4	2/1500	6	20	25
Redwood City Main	18	4	2/1500	6	20	25
AV/Fairoaks *	19	4	4/3000	12	20	37
Schaberg	20	2	2/1500	6	20	37
San Bruno	9	4	2/1500	6	20	- micro-cable
San Mateo City	13	4	2/1500	6	-	25
Main	14	3	2/1500	6	-	25
* Hills/Marina	15	2	3/2250	9	-	37
San Mateo County						
Brisbane/Foster C.	5	4	3/2250	9	20	60
Sanchez	6	2	2/1500	6	20	25
Pacifica	7	3	2/1500	6	20	25
Half Moon Bay	8	3	2/1500	6	20	25
Millbrae	10	3	2/1500	6	-	43
Belmont	16	3	2/1500	6	-	25
San Carlos	17	3	2/1500	6	-	53
Atherton/East PA	21	4	3/2250	9	20	52
Woodside/Portola	23	4	3/2250	9	20	37
So. San Francisco * Grand	4	4	3/2250	9	20	37
Total			55/41250	165/mo.	300/mo.	811/mo.
				1980/yr.	3600/yr.	9732/yr.

* Installed later

COMMUNICATION COSTS

CENTRAL ONE-TIME COSTS	
Microwave System Installation Includes tower construction, multiplex channels, cable, and installation labor	$53,000
Dial-up Modem and 5 spare modems	5,000
PT & T Leased Line Installation	2,700
Local data modem Installation	3,000
LOCAL ONE-TIME COSTS	
55 Data Modems @ $750	41,250
LOCAL ON-GOING COSTS	
Modem Maintenance (first year)	1,980
Microwave Maintenance (first year)	3,600
PT & T Leased Line (first year)	9,732
Total	$120,262

UNIVERSITY OF MARYLAND

TELECOMMUNICATIONS RESEARCH PAPER

EXCERPTS

By

Patricia Copenhaver Rich
219-60-8752
11/22/82

F I N A L D R A F T

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GENERAL OVERVIEW

The University of Maryland is currently involved in an extensive planning process to evaluate and recommend alternative communications for the new GEAC 8000 library system. This will include an evaluation of short term and long term investment into data communications equipment and media.

This paper will present a background on the current telecommunications options and a cost analysis of these options. A recommendation will be made for the most efficient and economical communications system for the whole network. This could involve a single data communications medium or a combination of media.

The technology push in the telecommunications industry today is ever increasing. More economical, cost efficient systems are being researched and developed daily within this highly competitve area. The University may be limited now to a more developed medium because of cost restrictions or reliability. Other media will become more attractive as the industry develops but careful consideration must be given before a new data communications system is adopted. I will make a recommendation on a future system based on the information available today.

A presentation of the telecommunications industry will be presented as background before the discussion of alternative telecommunication means. I will then present an estimated cost analysis and discussion of the more feasible alternatives derived from information obtained from vendors of these media. Finally, a recommendation of short and long term communications will be made.

data rate, distance, number of users per system, approximate cost and application. It is a quick reference for determining feasible media in a local network.

Carrier services offered by the large companies are varied and widespread. Taking into consideration these figures and services currently offered, a recommendation will be made for short and long term telecommunications. All figures stated were received from national corporations and are estimates of current market prices. Prices will change by company and geography, but these were obtained to give a "ball park" figure for recommendations.

4.2 SHORT TERM RECOMMENDATION

In the next 1 - 3 years, I would recommend to continue using the Bell System DDS lines at 96K baud to communicate between campuses. Please see Figure 3. A centrally located data concentrator should connect all multiplexers on each campus. Each multiplexer should tie two or more terminals to the concentrator. I would recommend intra-campus connections to be purchased coaxial or twisted pair cable, depending on baud rate desired. If cable is already existing in the buildings affected, the cost of purchasing and laying intra-building connections would be minimal.

Another possible inta-building connection would be microwave links. Though the initial cost is high, easy installation, lessened error rates, and additional security benefits may outweigh the cost factor. A typical microwave/cable network design is shown in Figure 4. I see microwave as a very suitable solution to the campus communication problem for today, as well as the future.

4.3 LONG TERM RECOMMENDATION

As technology increases in the next 5 - 10 years, the cost of fiber optic and satellite links will decrease and become feasible for the University's purposes. As much as we can see developments in the future, the use of fiber optic long-haul transmission will be optimal for the University's purposes. Decreased error rate, increased bandwidth and lessening of electro-magnetic interference will make the fiber optic cable concept extremely desirable. As cable prices decrease, it may even be possible to hardwire fiber optic connections between campuses alleviating rental fees from public corporations. Please see Figure 5 for a likely network design. Satellite transmission systems are being used more frequently each day. As the number of dedicated earth stations increase, the price for rental of the stations will decrease. By 1987, it may be feasible to

rent satellite transmission services between the College Park campus and Eastern Shore campus. A likely network configuration is shown in Figure 6.

Though none of us can see into the future, we all must realize that telecommunications technology is always pushing forward and the future will bring better and better means of data communications to fulfill the world's needs.

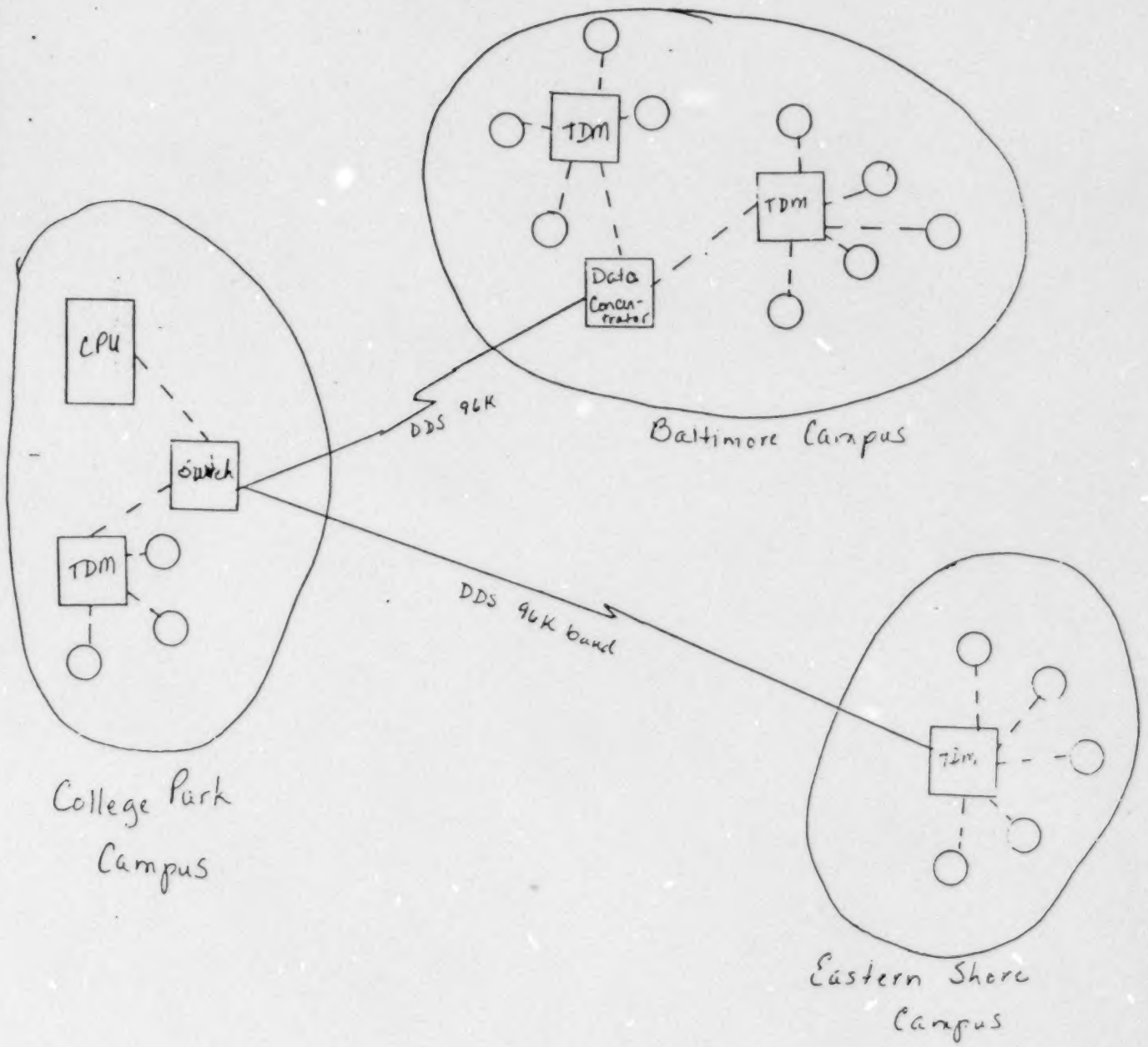

Figure 3

TDM - Time Division Multiplex
— — — Coaxial / twisted pair cable

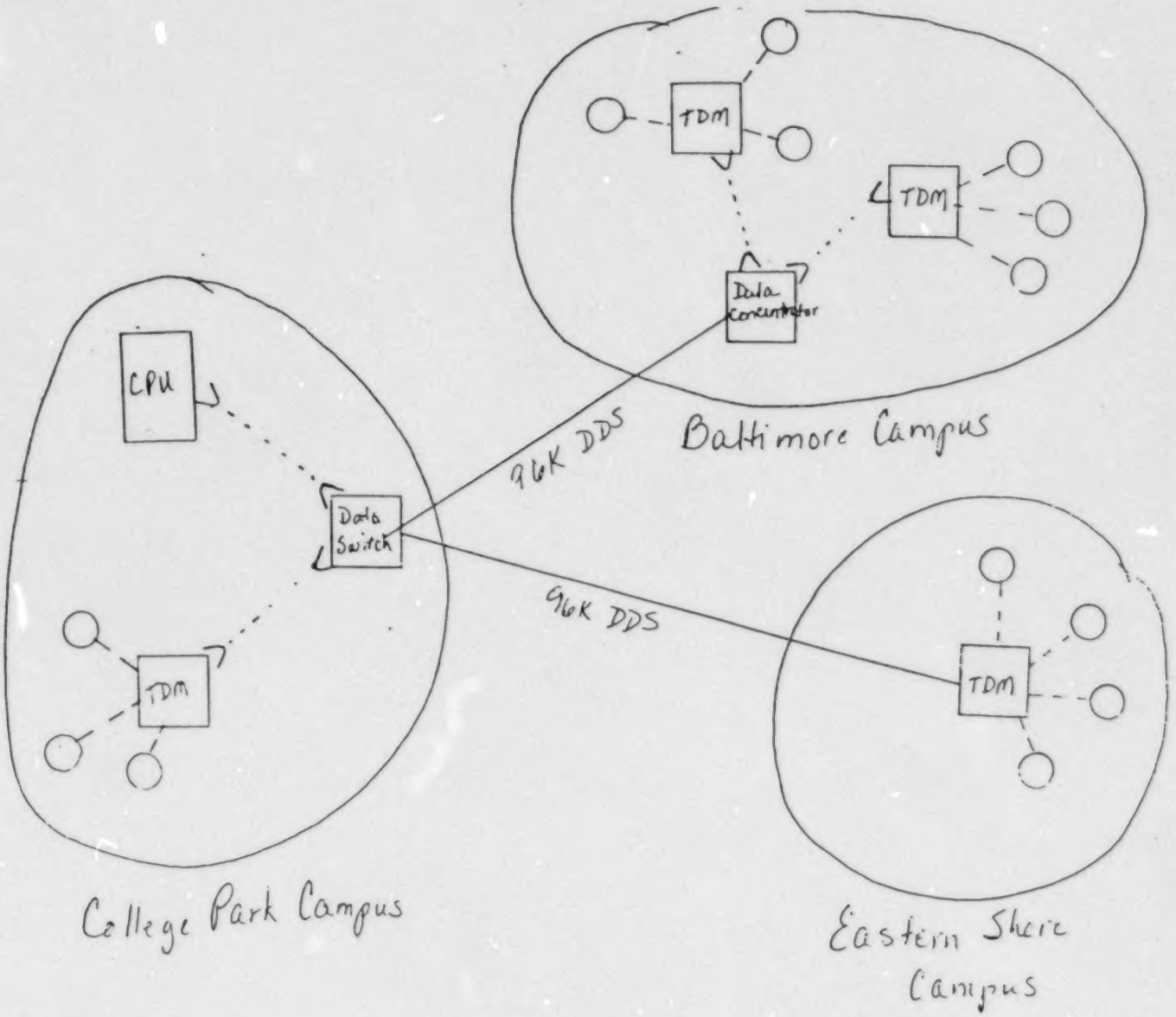

Figure 4

>· · · < Microwave

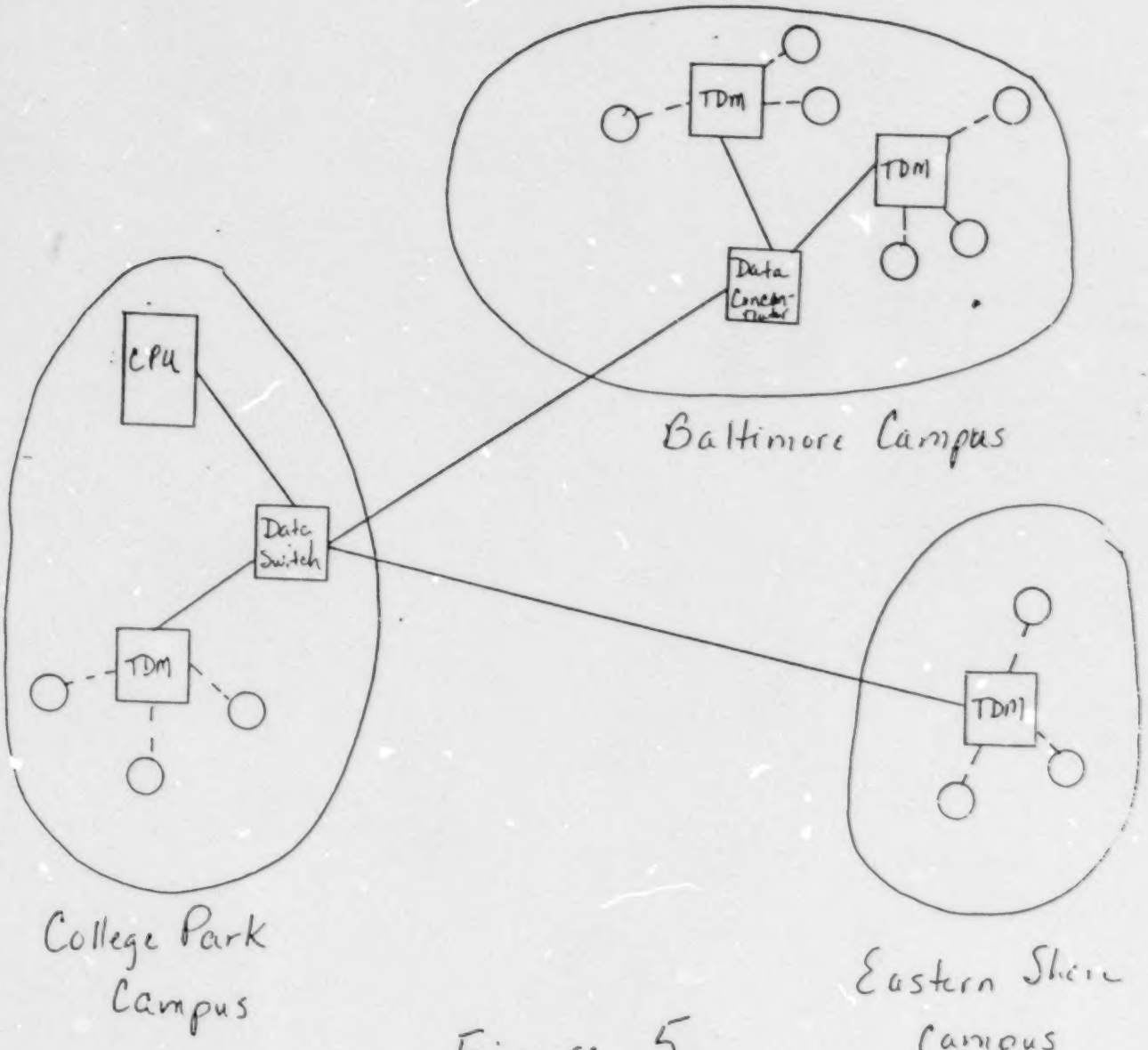

Figure 5

— — — Fiber Optic or Coaxial Cable

——— Fiber Optic Cable

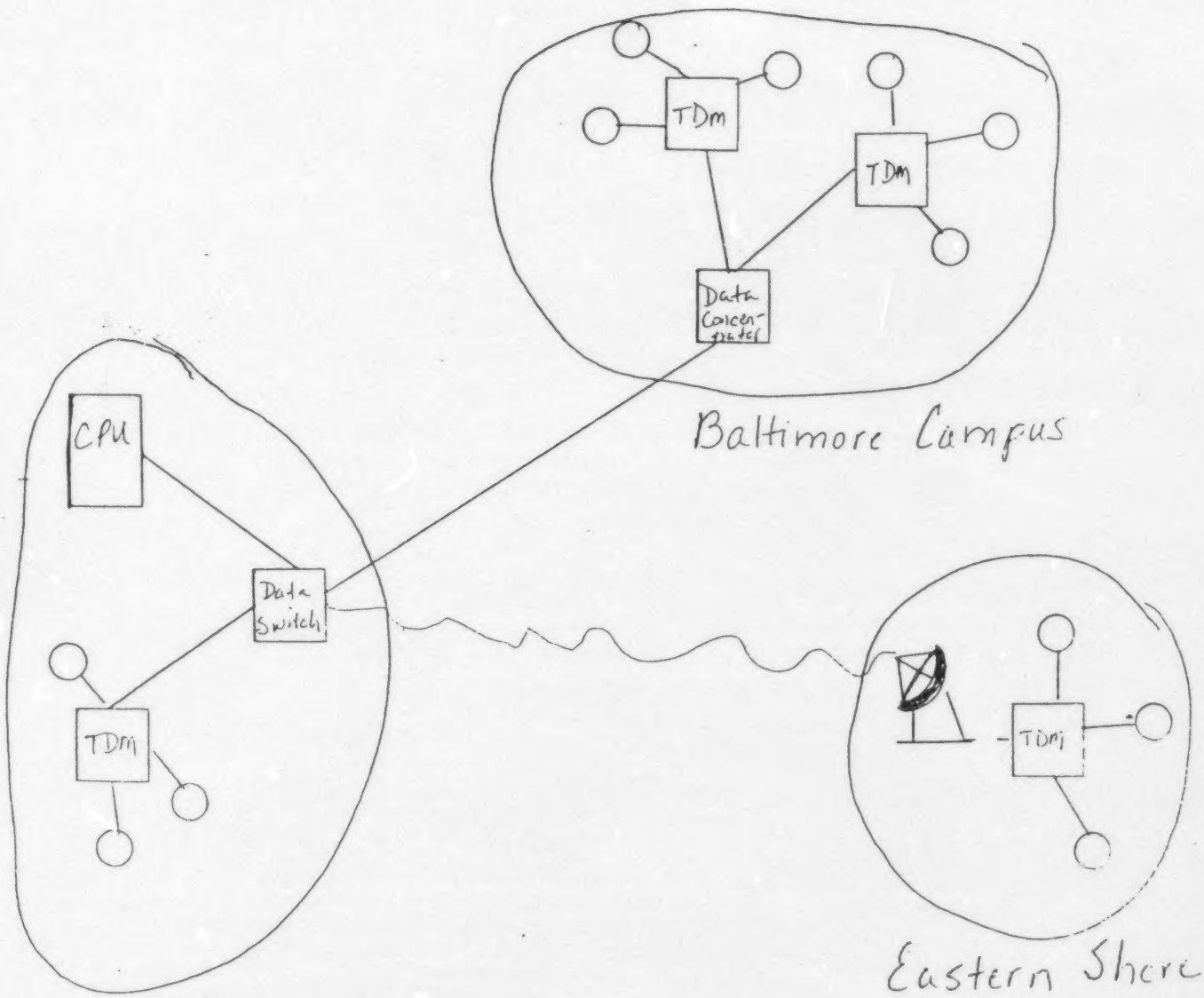

Figure 6

——— Fiber Optic Cable

NEW YORK PUBLIC LIBRARY

31 January 1983

EXCERPTS

Automation Requirements -- The Branch Libraries

Summary

The following are the automation requirements of the Branch Libraries. They are divided into four major chronological, or priority groupings: (1) current requirements that need to be satisfied to ensure the continuing effective operation of The Branch Libraries; (2) relatively well-defined requirements that we can expect will be implemented in the short term (within the next 5-8 years); (3) facilities that we can expect will be implemented in the medium term (within the next 8-15 years); and (4) developing, but not yet fully mature applications whose priority has not been precisely fixed.

Though the outline to follow is presented from the perspective of The Branch Libraries, it should be apparent that many of the same considerations apply to the Library as a whole, and, in fact, many of the potential opportunities are best exploited as institutional ventures.

The discussion that follows makes apparent the increasingly significant role that information processing and communication technologies will play in the future operations of the Library. The applications described are numerous and constitute an agenda that will require some two decades for its realization. Yet in many ways it is a conservative proposal. It is not a recommendation for research and development intended to extend the reach of technology. Rather, it represents a logically inevitable series of steps necessary to take advantage of commercially proven applications of technology. In a sense it represents a minimum agenda which circumstance and the availability of resource may enrich. It does not seem likely that it can be significantly diminished if an institution of the size and complexity of The New York Public Library is to retain its ability to function effectively. Thus, it appears relatively clear that the Library will need to maintain its information processing capability if it is to maintain its position of eminence, and will need to strengthen that capability if it is to excell.

The present and foreseeable future can be characterized by a more or less permanent scarcity of public funds. Thus, excellence will cease to be a luxury. The economic climate promises to be so bleak that only services deemed to be clearly superior (or which are necessary to protect life or public safety) will survive the competition for public support. Creative applications of technology seem the most certain means to enhance materially the quality of the service delivered while yet containing the inexorable rise of costs.

Current Requirements

- --Automated Bibliographic Control
  - --Copy Cataloging
  - --On-Line Union Catalog
  - --Printed Book Catalogs
  - --Special Catalogs and Bibliographies
- --Serials Lists
- --Acquisitions
- --Circulation Control
- --LB Inventory Control and Material Selection
- --Information Handling System

Short Term (5-8 years) Requirements

- --Automated Circulation Control
  - --Communication Network
  - --Film Booking
  - --IBL/ILL System
- --TEC Files On-Line
- --On-Line Reference Services-Pilot Programs
- --Electronic Mail
- --Microcomputer Systems
  - --Word Processing/Statistics/Graphics
  - --Educational/Independent Learners Program
  - --Intelligent Terminals
  - --Facilitate On-Line Data Base Access
  - --Instruction and Training
  - --Standardization
  - --Inter-system Communication
- --Upgrade Acquisitions System
- --On-Line Information and Referal
- --Serial Control/Serial Check-in
- --Conversion from Paper to Electronic Files
- --Video disk/Microcomputer Systems
- --Public Access Catalog

Medium Term (8-15 years) Requirements

- --Gateway Facilities
- --Administrative Support Systems
- --Integrate On-Line Reference, Circulation, and Public Access Catalog Systems.
- --Integrate Branch and Research Library Systems
- --Collection Development
- --Large Scale System Integration

Long Term Requirements

- --Videotex
- --Remote Service Delivery
- --Teleconferencing.

3. Medium Term Requirements

It is obviously foolhardy to attempt to predict what technologies or technological applications will be dominant in the next 8-15 years. However, it is fairly safe to predict that during this period of time the gains made in the first 5-8 years will be consolidated and integrated into a synergistic whole. The widespread availability of a broad class of disparate systems which perform a variety of essentially complementary functions can be expected to give rise to a serious concern for mechanisms that facilitate their interconnection, or integration.

We shall assume that the dominant themes of the medium term period will be system integration, and implementation of those applications which were not mature enough or urgent enough to have been considered for implementation in the near term.

Gateway Facilities. An increasing number of complementary on-line services are becoming available. They are provided by a number of different suppliers many of whom employ incompatible equipment and protocols. Thus, great interest has developed in generalized, intelligent switching facilities, Gateway Facilities, which permit a single terminal at any location to access with equal facility a host of different sevices. American Bell is pursuing such a concept with its Advanced Information

System, AIS 1000; a group of Canadian telephone companies, the Computer Communicatons Group, CCG, has developed and is marketing the most advanced Gateway system available today, iNet; OCLC too is engaged in an effort to develop a Gateway Facility specifically intended to serve libraries.

The availability of a Gateway Facility, whether developed in-house or supplied by a communication company will give us the means necessary to effect increasingly higher levels of system integration. Gateway Facilities will permit the imlementation of a virtually limitless number of systems configured to satisfy a variety of unique requirements, yet utilizing only a limited number of basic components. The individual components could include different systems operted by NYPL or services supplied by commercial vendors.

The prospects of higher levels of integration will place an increased emphasis on developing and ensuring conformity with data and other technical standards. This will become an increasingly important management responsibility; further suggesting the need to maintain an effective information processing, or information management capability.

Administrative Support Systems. The increased availability of mirocomputers, and computer terminals that permit access to a

variety of data bases will result in the increased use of automated systems in support of administrative activities. We can cite a few examples as illustrations:

A considerable amount of effort is expended in making up and revising schedules for 82 branches and 14 regions. Automted assistance in this task will make a significant contribution to the productivity of professional staff.

Fluctuation in the economic fortunes of The Branch Libraries are generally reflected in transfers of staff, changes in schedules, and changes in branch hours. Automated assistance in developing such contingency plans would ensure that they could be developed with considerably less effort, more rapidly, more accurately, and would permit a wider range of alternatives to be studied.

Developing project or funding proposals consumes substantial amounts of middle management time and effort. If automated assistance could be provided in the budgeting process considerable productivity could be gained. A complementary system with appropriate interfaces with IHS could be used to track the expenditure of project funds. Thus, permitting a further gain in productivity and better use of available project funds.

Integrate On-Line Reference, Circulation, and Public Access Catalog Systems. Patrons with access to on-line reference data bases after locating a particular citation will want to know whether the item in question is held by NYPL or one of its cooperating partners; having determined which institution holds the item in question they would wish to know if it is currently available; if it is, but not locally, they would probably wish to request that it be made available to them. Thus, in order to satisfy the demands of an increasingly technologically sophisticated public it will be necessary to provide facilities which integrate a number of public access services.

The Library will not necessarily need to develop such systems. Nonetheless, it must possess the capability to select those which are most appropriate and which integrate properly with the remainder of its repertoire of technical facilities, plan for their implementation, oversee their operation, plan for their replacement, and select the optimum time for replacement. This requires staff with considerable technical expertise.

Integrate Branch and Reserch Library Systems. It seems curious that both the Branch and Research Libraries are engaged in computer mediated cooperative ventures with other institutions, but are

unable to engage in such activities between themselves, or even possess systems which permit each to make easy, efficient referal to the other. Thus, one of the Library's major priorities should be to implement appropriate facilities to permit whatever systems The Branch and Research Libraries use to communicate readily.

The development and availability of Gateway systems will facilitate this. Thus, anticipated technological developments will permit the Library to recover a unity that was lost as a result of circumstances which compelled The Branch and Research Libraries to pursue independent courses for their technical support and development.

Technological developments alone will not suffice to achieve a reintegration of systems used by the two halves of the Library. It will be necessary to develop and adopt common data and technical standards, to propose and make particular accommodations in the systems used by each, to acquire and implement services and equipment that facilitate system integration, and to oversee the effective operation of the intersystem interfaces. The foregoing matters are most effectively handled by an institutional unit charged with responsibility for information processing.

Collection Development. Before the end of the short term we can expect that cost effective access to data bases containing ordering information detailing availability of materials will become available. However, not until the ability to access these data from a variety of terminals performing a number of other functions is available will we be able to make effective use of these services. Thus, this matter has been deferred until the medium term.

Large Scale System Integration. Within the next 5-8 years automated systems to support the overwhelming majority of the applications we have identified up until this time will have been developed and sufficiently refined. The next major challenge will then be to integrate the individual facilities into a coherent, automated system that permits libraries to be operated and managed effectively.

Failure to reach the maximum achievable levels of integration will result in redundant effort, inefficient use of resources, and lost opportunities to improve performance or to enhance productivity.

4. Long Term Requirements

This final grouping of technological applications does not represent an attempt to estimate what opportunities we might wish to exploit more than 15 years from now. To do so would either be total

folly or the height of hubris. The enumeration to follow represents instead a compilation of applications of technologies that are not yet fully mature, and whose priority relative to the matters already discussed is still unclear.

Videotex. Perhaps the most exciting and promising technologies for information dissemination are Videotext and Teletext (known generically as Videotex). Both feature extremely simple access protocols, and extensive use of color and graphics; features which make the technologies particularly well suited for public access systems. They permit non-verbal information such as scientific diagrams, maps, and illustrations to be stored and retrieved in addition to traditional text information.

A system with these capabilities has obvious appplication in independent learning programs. High resolution, color graphics add other dimensions to information in text form. Such information is comprehended more rapidly with less ambiguity. Because displays are under computer control, illustrations can even be made to depict the development of complex processes. Such a system is particularly well suited to communicating abstruse scientific or technical information. Yet, it has an equally great potential as a facility to help enhance literacy.

Remote Service Delivery. Further development of broad band communication systems (coaxial cable, optical fiber, microwave, and

satellite systems) will permit public libraries to reach their clients in a variety of new, and imaginative ways. The public will become increasingly used to receiving a broad range of services in their own homes via low cost terminals supplied or subsidized by any number of commercial enterprises. Thus, we can expect that in 10-15 years the individual components necessary to deliver information to users regardless where they may be when it is needed will be in place. Videotex will play an obvious role in such a scenario.

Teleconferencing. The presence of adequate broad band communication facilities combind with a variety of innovative image transmission techniques already being developed will lead to widespread use of teleconferencing. It is not entirely clear how such a technology will be employed by NYPL, however, its potential is such that it bears close watching.

EXCERPTS

Report no. TG.1.5

Application Level Protocol Development

for

Library and Information Science Applications

Volume 1

Service Definition

Council on Library Resources

Grant 2033

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October 29, 1982

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1. INTRODUCTION

In order to achieve long-range goals of linking the central computing capabilities of bibliographic networks to each other and to local computing systems at libraries which are members of these networks, it is necessary to establish communication protocols which will be accepted and used by all of the participants.

As a first step in this process the Telecommunications Committee of the American Library Association began work in 1975 on a protocol for computer-to-computer communications. In 1976 a task force was established by the National Commission on Libraries and Information Science (NCLIS), in cooperation with the National Bureau of Standards (NBS), to continue the work on communication protocols. Although the protocol proposed by the NCLIS/NBS group [NTAG-77-80][1] was described as an application protocol, in reality it includes features of what became defined as several levels in the layered ANSI/ISO Reference Model for Open Systems Interconnection which was taking form at the same time (see section 2).

An organization which was then called the Network Advisory Group (to the Library of Congress) established a task force of technical staff from library networking organizations called the Network Technical Advisory Group (NTAG). This group, which began meeting in 1977, examined possible mechanisms by which the goal of interconnection might be achieved.

In the fall of 1977 the Library of Congress awarded a contract to the New York Public Library (NYPL) to begin some of the work recommended by the NCLIS/NBS and NTAG groups. NYPL subcontracted with experts in the field of library automation; this group became known as the Protocol Implementation Planners, and produced a final report in August 1978 [NTAG-78-21]. There appears to be no recorded attempt to further refine or implement the recommendations of these three groups. Further work has been undertaken by the American National Standards Institute, Committee Z39, Subcommittee D (ANSI Z39D) and by the National Bureau of Standards Institute for Computer Sciences and Technology (NBS/ICST).

The establishment of the Linked Systems Project (LSP) among the Washington Library Network, the Research Libraries Group, and the Library of Congress, has generated a new impetus for a resolution of the protocol problem. In July 1981 the Council on

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[1]The notation [...] is used in this document to reference an item in the bibliography.

Library Resources awarded grant 2033 to the Northwestern University Library to develop application and presentation level protocols which support the needs of Linked Systems Project, and upon which other library and information science applications may be built. The statement of these requirements may be found in [LASP-39].

Some of the requirements for this grant are:

1) A set of protocols will be developed to permit the exchange of messages between two applications running on different computer systems. Initially, the protocols must support Search and Retrieval, Record Maintenance, and Mail Transfer. The protocols must be extensable to File Distribution, Interlibrary Loan, and Book Ordering.

2) The protocols developed must follow the principles of Open Systems Interconnection as specified in the ANSI/ISO Reference Model for Open Systems Interconnection.

3) The protocols developed must reside in the application and presentation layers of the OSI Reference Model.

4) The development will be coordinated with ANSI Z39 Subcommittee D (Computer-to-Computer Protocols).

5) The development should draw from the protocol development work done by ISO, ANSI, and NBS to the fullest extent possible.

2. OSI REFERENCE MODEL

This protocol was developed using the architecture formulated in the Reference Model for Open Systems Interconnection (OSI) [DP7498]. The architecture was developed by the International Organization for Standardization to provide a framework for communications within a heterogenous network environment.

2.1 Layering Principles

The model calls for a hierarchy of several layers at each node in the network for communication processing. Figure 1 shows a schematic for the layering.

Layering is a technique which imposes an order and structure on the functions required to support computer-to-computer communication. All of the functions must be performed; layering clarifies the problem and simplifies the interaction between these functions.

Some of the benefits of layering are:

- the ability to "divide and conquer" a complex technical problem
- reduction of complexity by imposing a discipline on the interactions between system components by defining and limiting those interactions
- definition of a standard nomenclature for discussion and design of network systems
- definition of a standard architecture that facilitates and encourages the development of standard procedures for all levels
- the ability to replace any single building block with a better one without disturbing any of the others
- simplified error detection and program debugging

In deciding on the number and definition of the layers in the OSI architecture, the designers followed these guidelines:

1) Create only as many layers as necessary.

2) Create separate layers to handle functions that are significantly different in the processes they perform or the technology they use.

3) Put functions that are substantially similar in the same layer.

4) Create a separate layer where there is a need for a different level of abstraction in handling the data.

5) Create a layer of related functions in such a way that the layer could be totally redesigned to take advantage of advances in technology without changing any of the other layers.

6) Define the boundary between layers at a point that minimizes the number of interactions that must take place across that boundary.

7) Define boundaries at the points where they have occurred and been useful in the past.

8) Define a boundary where it may be useful to standardize the interaction with the adjoining layer.

9) Design boundaries so that each layer need only interact with its two adjoining layers, one above and one below.

A layer only provides services to the layer immediately above it. The point at which two layers meet is termed the "interface". A given layer provides services to the layer above through the upper interface, and requests the services of the lower layer through the lower interface.

Each system engaged in a connection will have the seven layers defined in the Reference Model. An entity is a process or module that performs the services required of the layer within a single system. Entities in the same layer are called "peer entities".

Peer entities communicate according to a set of rules. This set of rules is termed the "protocol" of the layer. The protocol provides for a predefined set of procedures and formats. Through this protocol, peer entities can control the flow of information. A unit of data, in a predefined format, passed between two peer entities is called a "protocol data unit", or "PDU".

Control information and data will be passed to the peer entities using the services of the lower layers. The lower layers provide a virtual link between the peer entities. Communication actually proceeds down through the lower layers, across the physical link, and up through the layers until it reaches the peer entity of the associated layer.

To accomplish this, each layer (except the application layer) provides a connection for the delivery of the PDUs of the next higher layer. It does this by inserting the higher layer's PDU into one or more of its own PDUs, and then requesting the delivery of its PDUs by the next lower layer[1]. Each peer entity, upon receiving a PDU, extracts and assembles the higher layer's PDU and passes it to the higher layer.

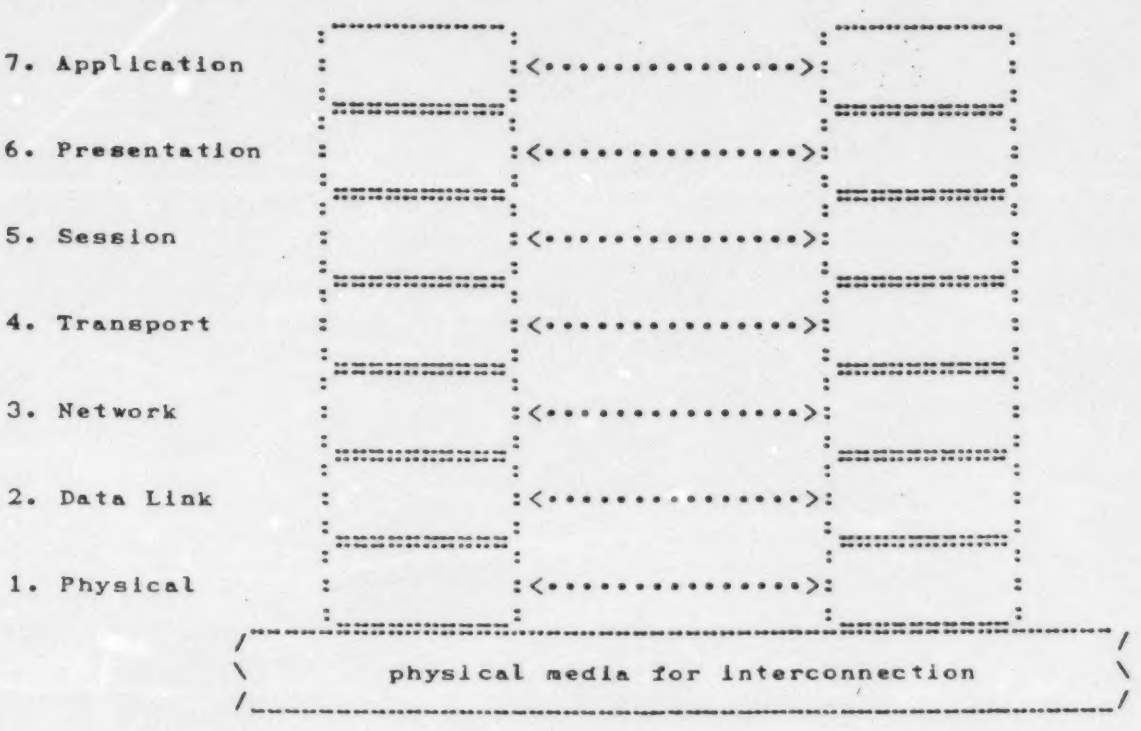

Figure 1. OSI Model

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[1]note that the physical layer actually transfers the data across the physical medium

3. OVERVIEW OF THE APPLICATION LAYER

3.1 Role of the Application Layer in the OSI Model

The protocol discussed in this document resides at the seventh level of the OSI model -- the application layer. It implements the features necessary for bibliographic searching, record maintenance, and mail transfer between end-user application processes in library and information sciences.

As the highest layer in the OSI Model, the application layer provides services not to a next higher layer, but to the end-user application processes which are the users of the OSI environment. Protocols at this layer are generally industry specific.

All user specifiable parameters of each communications connection are made known to the OSI environment via the application layer. All specification of the semantics of information exchanged not otherwise implicit among users of the OSI environment is provided via the application layer. Conversely, as the only layer in the OSI environment that directly provides services to the end-user application processes, the application layer necessarily provides all services that are directly accessible by the end-user application processes. These services include, among others:

a) identification of intended communications partners
b) determination of current availability of an intended partner
c) establishment of authority to communicate
d) agreement on privacy mechanisms as required
e) authentication of intended partners
f) determination of cost allocation methodology
g) determination of adequacy of required resources
h) determination of acceptable quality of service
i) synchronization of cooperating partners
j) selection of dialog discipline, including initiation and release procedures
k) agreement on responsibility for error recovery
l) agreement on procedure for data validity commitment
m) identification of constraints on data syntax
n) information transfer

3.2 General Characteristics of Application Service

The service is designed to handle program-to-program communications. Program-to-terminal and terminal-to-terminal communications are not addressed by the service.

5. SERVICE DESCRIPTIONS

5.1 Connection Services

Before two application processes may communicate, they must establish a connection. Once established, a connection may be used until terminated.

The originating end-user application process issues the A ESTABLISH request. The originator may bid various parameters, such as the the subset of application services to be used. The target end-user process must reply with either an A ESTABLISH response or an A ABORT request. If the target accepts connection, it may also accept the originator's parameters, or it may bid a more restrictive set, which will then be in effect. If the target aborts the connection, it will supply a reason code.

Connections may be terminated gracefully or abruptly. To terminate gracefully, either end-user process may issue the A RELEASE request. The other end-user must reply with the A RELEASE response. To terminate abruptly, either end-user process may issue the A ABORT request. The application receiving an A ABORT indication does not respond.

5.2 Information Retrieval Services

These service elements support a general query structure which can be applied to specific data files and processing capabilities by agreements between communicating applications. This structure is a mechanism for communicating search queries between applications in a mutually understandable form. It is the responsibility of the end-user application process originating a query to translate its local user query into the network form. It is the responsibility of the end-user process receiving a query to translate the network form into its internal processing form.

The result of a search query is a "result set", which is maintained by the target application. The target assigns and returns a "result set identifier" with each result set. Each target application must retain at least the most recent result set. It may also retain additional, previous result sets during the session if specified by the result set dispostion subapplication parameter. If the target is retaining multiple result sets, the originating application may make an A DISCARD RESULT request.

The basic query concept is "Retrieve from the specified set of items those items with the properties indicated," e.g. "Find those records in the MARC Authority Format file which contain the

word Library in a corporate name," or "Find those records in MARC Books Format with the LC Catalog Card Number 76-86995."

It is assumed that certain common sets of items will be known to all host systems by a common name, e.g. MARC BOOKS. Other sets will be identified by specific names assigned by the application holding the set, e.g. Eighteenth Century Short Title Catalog. An end-user process wishing to access such a set must determine the specific name, either through a directory or through prior agreement.

Properties are composed of values with certain attributes, e.g. the value "Roots" with the attribute of being a title. The service will provide for a truncation attribute. Relational attributes may be used. Logical operators may be used to specify the relationships among various terms and/or result sets, e.g. the value "Heritage" as a title word OR the value "England" as a geographic subject. Reverse Polish Notation (RPN) is used to support nesting of logical operators, e.g. (property1 AND property2) OR property3.

RPN is a form that places logical operators after the terms on which they operate. This practice is known as "postfix operator notation". The practice provides an unambiguous statement of the order in which the operators are to be exercised, without requiring the use of parentheses. The query

"author=jones OR (author=smith AND date>1947)"

would be expressed in RPN as

"author=jones author=smith date>1947 AND OR".

RPN is usually processed by storing the intermediate results on a stack. The steps in processing the query would be:

a) Process the first item "author=jones" and place the result set on the (empty) stack.
b) Process the second item "author=smith" and place the result set on the stack.
c) Process the third item "date>1947" and place the result set on the stack.
d) Process the fourth item "AND" against the top two result sets on the stack (b and c, above), replacing them with the single result set.
e) Process the fifth item "OR" against the top two result sets on the stack (a and d, above), replacing them with the single (final) result set.

RPN is a convenient way for an application process to construct a query, since it makes it simple to ensure the correct order of evaluation, and does not require the program to format a text string.

An end-user process using these services must recognize all of the standard parameters specifying item sets and properties but it is not required to support all of them. The service provides a "feature not supported" return code. There also is an option for the target end-user process to reply with a suggested alternate form of the search query which the target does support.

The originating end-user process is allowed to specify the manner in which the results of a search query and the retrieved items are transferred back to the origin. A "fullness code" is provided to indicate which of several levels of record completeness will be provided. Options include:

transmission of only the count of the number of items retrieved

specification of full or brief form of the items retrieved

transmission of both the count and some number of items in form specified

transmission of a specified number of retrieved items, with the ability to specify an offset from the beginning of the result set

An A FETCH RECORD request is provided which enables an originating end-user process to retrieve a single item by specifying a unique key for that item. This type of retrieval does not affect the contents of the result set for a search query in progress. It is possible to specify either the full or brief form for transmission of an item retrieved in this manner.

5.3 Record Maintenance Services

Although the service elements described in this section are oriented specifically toward the needs of the Linked Systems Project, as described in [LASP-39], it is believed that they will be adequate for other library network environments.

The record maintenance services provide the capability for the originating application to request changes in files located at the target application. The basic services which are provided are A ADD RECORD, A REPLACE RECORD, and A DELETE RECORD.

7.3 Information Retrieval Facility

7.3.1 A_SEARCH Service Element

Function: Request a search of a database at the target system.

Valid phases: Information retrieval

Primitives and parameters:

Parameter	Req/Ind	Res/Con
Query	X	
Search_status		X
Result_count		X
Result_set_ID		[X]
Fullness_code		[X]
Search_diagnostic		[X]
Alternate_query		[X]
Number_of_records		[X]
Data		[X]

7.3.2 A_PRESENT_RECORDS Service Element

Function: Request the return of records retrieved by a search.

Valid phases: Information Retrieval

Primitives and parameters:

Parameter	Req/Ind	Res/Con
Fullness_code	X	
Result_set_position	[X]	[X]
Number_of_records	[X]	[X]
Result_set_ID	[X]	
Data		X
Present_status		X

7.3.3 A_DISCARD_RESULT Service Element

Function: Request that a result set be no longer retained. A result set which is discarded, including CURRENT, becomes undefined. Subsequent attempts to reference it will cause a result set ID error.

Valid phases: Information Retrieval

Primitives and parameters:

Parameter	Req/Ind	Res/Con
Result_set_ID	[X]	
Discard_status		X

7.3.4 A_FETCH_RECORD Service Element

Function: To obtain a particular record identified by a record key without creating or changing any result sets. If a file name is supplied, it overrides the file name supplied as a subapplication parameter.

Valid phases: Information Retrieval

Primitives and parameters:

Parameter	Req/Ind	Res/Con
Fullness_code	X	
Record_key	X	
File_name	[X]	
Fetch_status		X
Data		[X]

7.4 Record Maintenance Facility

7.4.1 A_ADD_RECORD Service Element

Function: To add a new record to a file. If a file name i supplied, it overrides the file name supplied as a subapplication parameter. The record key may be supplied by the system making the ADD request; alternatively the receiving system may assign the record key, in which case it will be reported through the ADD_VALIDATED service element. If the requesting system has selected the validation mode, the responding system will assign a transaction reference number and return it in the response.

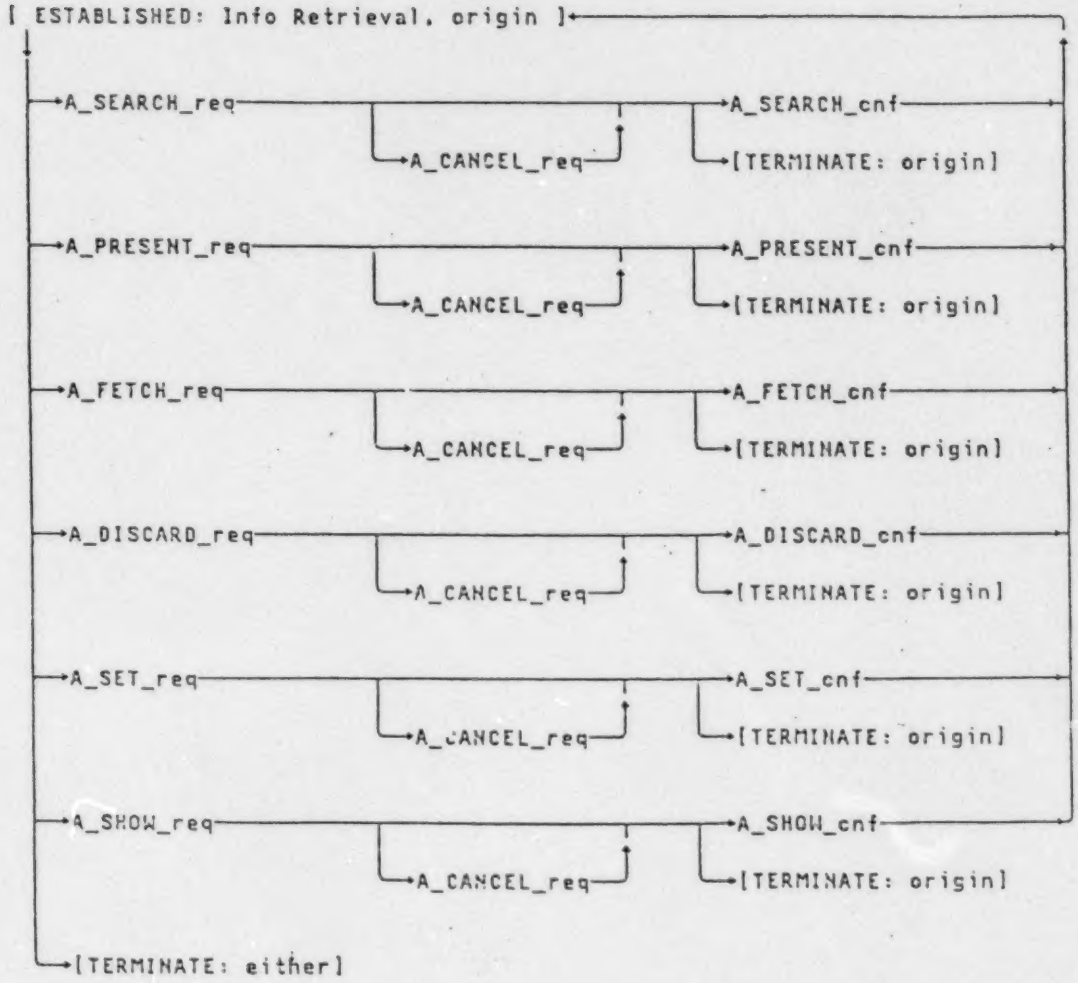
Valid phases: Record Maintenance Request

Primitives and parameters:

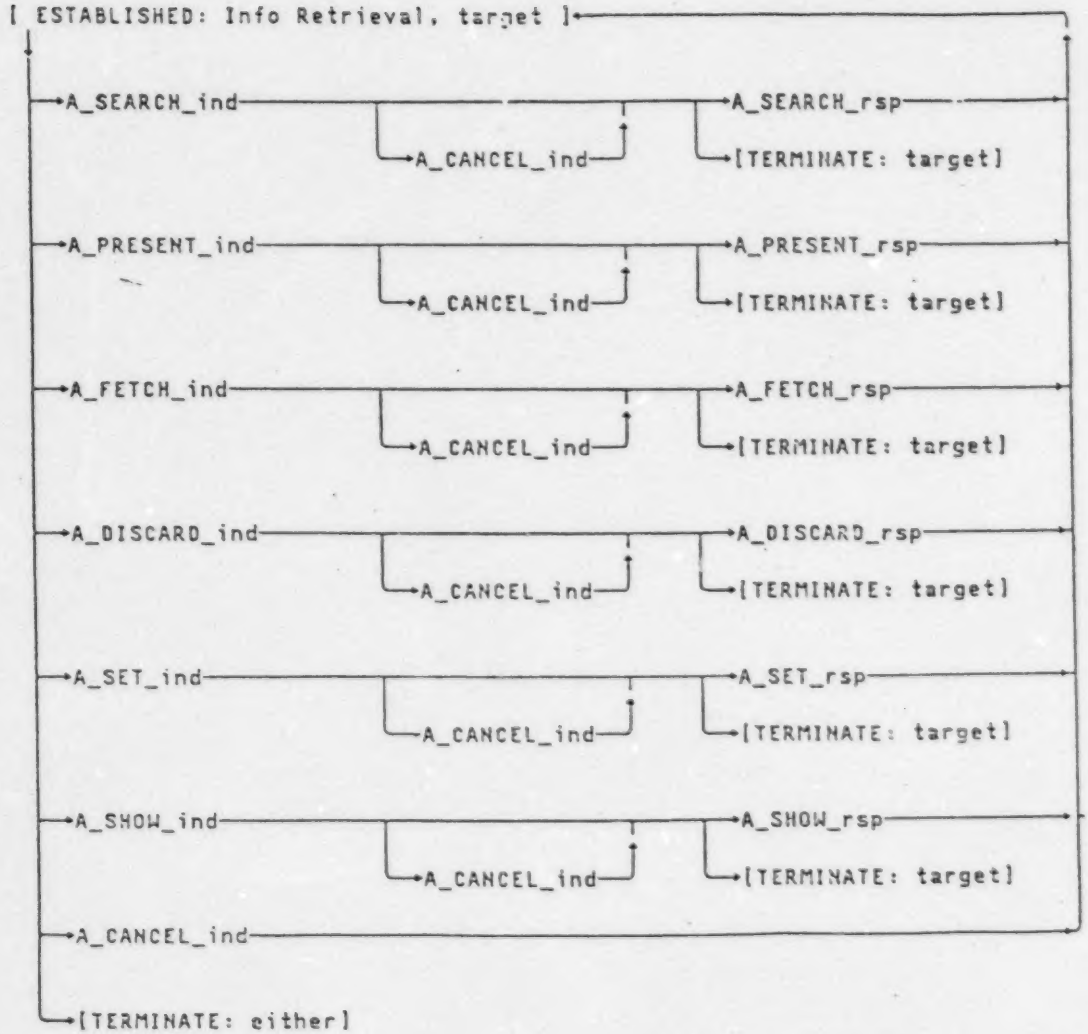
Parameter	Req/Ind	Res/Con
File_name	[X]	
Record_key	[X]	
Transaction_reference_number		[X]
Add_status		X
Data	X	

9.2 INFORMATION RETRIEVAL

9.2.1



9.2.2


[ESTABLISHED: Info Retrieval, target]
A_SEARCH_ind
A_CANCEL_ind
A_SEARCH_rsp
[TERMINATE: target]
A_PRESENT_ind
A_CANCEL_ind
A_PRESENT_rsp
[TERMINATE: target]
A_FETCH_ind
A_CANCEL_ind
A_FETCH_rsp
[TERMINATE: target]
A_DISCARD_ind
A_CANCEL_ind
A_DISCARD_rsp
[TERMINATE: target]
A_SET_ind
A_CANCEL_ind
A_SET_rsp
[TERMINATE: target]
A_SHOW_ind
A_CANCEL_ind
A_SHOW_rsp
[TERMINATE: target]
A_CANCEL_ind
[TERMINATE: either]

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Melvin Gelman Library Establishes

Telecommunications Information Center

The Melvin Gelman Library and the Center for Telecommunications Studies (CTS) of the George Washington University announce the formation and co-sponsorship of a Telecommunications Information Center. Recognizing that Washington, D.C. is the capital for the telecommunications industry, James B. Alsip, University Librarian and Dr. Christopher H. Sterling, Director of CTS, have undertaken to develop an extensive reference center which will provide information in policy, management, and research areas of telecommunications.

Separately housed within the Gelman Library of the George Washington University, the new Telecommunications Information Center will include books, documents, periodicals, and data base services and will become a major depository for telecommunications materials in the face of declining related government library facilities in the Washington area. The Center will include material on most aspects of the economics, technology and regulation/policy of broadcasting, cable communications, common carrier (telephone and related services), communication satellites, teletext-videotex services, electronic mail, mobile communications services and the computer-communications interface.

The Telecommunications Information Center will actively cooperate with existing corporate and government telecommunications libraries here in Washington and in other areas. The Gelman Library and CTS cooperative effort will provide services and materials to professionals and students working in all areas of telecommunications. Plans are actively underway to acquire references which are essential to facilitating research in a field which is undergoing rapid and important changes. These include conference papers, dissertations and theses, government agency policy and planning documents, research papers from government and industry, etc.

The Telecommunications Information Center--because of its Washington location, resultant visibility, and university-based commitment to innovation and quality--will provide reference support to the academic community, government, and industry long sought in telecommunications by these entities. The sponsoring organizations, Gelman Library and CTS, are pleased to respond to the mounting demand for information about telecommunications.

For further information, contact James B. Alsip (phone) 202-676-6455 or Judith A. Sessions (phone) 202-676-8272.

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